

1. WHAT IS A LICHEN?

Target Audience

9th grade and up

Subject

Distinguish lichens from other life forms and find them in various environments.

Objectives

Students will

1. Distinguish lichens from fungi, mosses, liverworts, and higher plants.
2. Identify the four basic growth forms of lichens: crustose (crusty), squamulose (flakey), fruticose (shrubby), and foliose (leafy).
3. Identify other general parts of the lichen.
4. Improve observation skills through drawing or photography.
5. Explore the variety of surfaces on which lichens grow.

Time Needed

Teacher preparation time: 1 to several hours, depending on the teachers' experience, materials needed and proximity to an area with lichens.

Classroom time: 1 hour to multiple class periods, depending on the focus of the class.

Materials

1. Hand lens (10-16x) and/or dissecting microscope with adequate light (lamp or well lit room)
2. Field or laboratory journal or paper, pencils, or what ever drawing supplies are available.
3. Digital camera (optional): must have close up capabilities.
4. A few lichen samples

Activity

Introductory lecture

Begin by going over the vocabulary listed below with the students. You can utilize visual aides, such as drawings and photos, available from resources listed in the Additional Resources page (marked with an *) or bring in your own material. Show the class how to use a handlens and then pass out examples of lichens so that students may practice using a handlens or dissecting microscope. After they feel comfortable using their handlenses or dissecting microscopes, have them learn the vocabulary list using the lichens you have given them. Especially important is to have the students break a thallus or cut a small cross section to see the layers of the thallus (cortex, photobiont layer and medulla).

Option 1:

A simple and effective way to engage students is to have them draw lichens. Have the students look for and draw specific morphological features of individual lichens and draw and color examples of the different lichen growth forms. Features to include in illustrations are listed in (but not limited to) the vocabulary section. Students can also observe and draw mosses and plants to observe how they differ from lichens. Other variations include drawing multiple lichens from a community, and the habitat in which they are found including associated plant communities. Drawing helps students notice differences between lichens and other plants and helps students put lichens in an ecological context.

Option 2:

A 'higher technology' activity is to observe lichen features and habitat as above using digital camera to document lichen morphology and habitats instead of hand drawings. Have the students photograph different lichens, growth forms and other plants for comparison, either in the field or back in the class room. Using a photo-editing program, students can add text boxes to label the lichen features listed in vocabulary.

Vocabulary

Difference between lichens, plants, and non-lichenized fungi

Lichens are fungi that develop and live in association with a green alga and/or a cyanobacterium. About one-quarter of all known fungi, world-wide, are lichenized. A more specific definition of lichen from the International Association for Lichenology is "an association of a fungus and a photosynthetic symbiont resulting in a stable vegetative body having a specific structure." Most lichens appear different from other fungi like mushrooms, yeasts, or bread molds and when cut or broken, they usually reveal distinct layers: a dense cortex, a green or blue-green photobiont layer and spongy medulla. The texture of lichens is usually more fibrous and stiff, especially when dry, compared to non-lichenized fungi which are usually soft, fleshy and delicate to the touch. Non-lichenized fungi lack a photobiont, therefore they do not appear green and you will not be able to find a layer of algae or cyanobacteria if you make a cross section. However, because of the broad scope of lichen appearances, there is no one-fits-all visual description, so don't be surprised when even a teacher can't decide whether to call a new find a lichen or not! For example, while most lichens are some shade of green, color can vary widely from black, brown, yellow and even bright orange—but internally all lichens contain algae or cyanobacteria.

Many people confuse bryophytes (mosses, liverworts, and hornworts) with lichens. Unlike lichens, bryophytes are true plants. They have tiny leaves, usually bright green, although yellow and even brown or red tinted bryophytes are common. The individual plants themselves are very small, but they can grow in colonies that form thick sleeves over tree trunks or branches, or make dense mats over logs or soils; they can even fill in a bog. As non-vascular plants, bryophytes have no specialized fluid transport tissues and thus dehydrate during droughty periods rather than drawing water up through roots

to maintain turgidity as plants do. That is why they are usually confined to moist habitats or microsites.

Though not as common a source of confusion, some vascular plants can be mistaken for lichens. An example is the plant called Spanish moss (*Tillandsia usneoides*). It is neither moss nor lichen! By definition, vascular plants have specialized tissues (xylem and phloem) for transporting food and water and are generally larger than non-vascular plants. Vascular plants includes all flowers, grasses, trees, shrubs, and vines, and there are even many aquatic plants. Their bodies are more robust, large and specialized when compared to non-vascular plants.

Lichen body parts

1. **Thallus** The vegetative lichen body as a whole, excluding the sexually reproductive parts.
2. **Cortex** The hardened outer layer of the lichen thallus, often some distinct color like brown, yellow or orange from pigments. Under a dissecting scope, the fungal hyphae (fungal 'cells') in this layer are densely packed and often uniformly shaped.
3. **Photobiont layer** The part of the lichen capable of photosynthesis and composed of an algal or cyanobacterial symbiont. Because the symbiont photosynthesizes, for brevity, it is called a 'photobiont'. The chloroplasts of the photobiont give the lichen its green color, brightest when the lichen is moist. There are two main types of photobionts.
 - a) Algal When the layer between the cortex and medulla is the color of *green grass*, not at all bluish, the photobiont is an alga.
 - b) Cyanobacterial When the layer is some shade of dark blue green or grey or even black (but not the yellow green color of grass!) the photobiont is a cyanobacteria.

(If you want to confirm the photobiont type for yourself, take a look at the photobiont layer under a light microscope. Algae are eukaryotes, cyanobacteria are prokaryotes.)

4. **Medulla** The white, fuzzy layer in the center of the lichen that often constitutes the majority of the volume of the lichen. The medulla is composed entirely of loosely-packed fungal hyphae. It is usually white.
5. **Rhizine** Rhizines are root-like structures that lichens use to attach themselves to their substrates. They occur on the lower surface of many lichen thalli and look like small hairs.

Growth forms

1. **Crustose** Growing like a crust or a stain, attached so closely to its substrate (i.e. the surface on which it is grows) that to remove it would destroy the lichen. Some conspicuous crustose genera are *Graphis*, *Lecanora*, *Lecidea*, *Lepraria*, *Ochrolechia*, *Pertusaria*, and *Rhizocarpon*.
2. **Foliose** Leaf-like or widely strap-shaped growth form. Foliose lichens have a distinct upper and lower surface, distinguishable by color, texture, or presence of

unique structures. Some common foliose genera are *Peltigera*, *Hypogymnia*, *Lobaria*, *Parmelia*, *Physcia*, *Platismatia*, *Rhizoplaca* and *Umbilicaria*.

3. **Fruticose** Distinctly three dimensional in shape, like a shrub, dangling network of threads or a pedestal. Some fruticose genera include *Usnea*, *Bryoria*, *Alectoria*, *Letharia*, *Ramalina*.
4. **Squamulose** Composed of small “foliose” thalli (squamules) but are much smaller and numerous, like little lichen “flakes” growing in patches or colonies. *Cladonia* is by far the most common squamulose genus, with well over 100 species in North America. Other common squamulose genera include *Hypocyrenomyces*, *Pannaria*, *Psora*, and *Stereocaulon*.

Teacher Preparation

Read one or several introductory chapters from the resources listed in the Additional Resource section marked * to gain confidence in your understanding of lichen morphology, vocabulary, habitats, and ecological roles.

Become proficient with a hand lens. To use the hand lens, take it in one hand and bring it to within a few inches of one eye. Using the other hand, move the object closer to the hand lens until it comes into focus. The object will seem very close to the face but this is normal. Try to not move the hand lens to focus the object, rather, move the object as this allows for a stable field of view. As one moves the hand lens away from the eye, the field of view gets smaller and details of the object become harder to see. If dissecting microscopes are available for your students, they are an ideal way to closely observe lichens for the first time. Their higher power (20x-70x), makes it much easier to appreciate the beauty and variety of lichen forms, shapes and colors. Adequate light is necessary to optimize hand lens and dissecting microscope optics. For the microscope, the light source can be either a lamp or a mirror positioned to best illuminate the object. Outdoor daylight is usually sufficient for hand lens observations.

Collect lichen samples of the four growth forms. To do this, find suitable sites for lichen collection. In general, lichens like high to medium light environments with frequent alternating wet and dry periods. Bryophytes (mosses and liverworts) tend to dominate poorly lit, continuously humid sites. Good substrates to search include trees, shrubs and woody debris, bare soils, decaying logs and recently fallen trees, boulder fields, rock cliffs, road and river banks, and stable river boulders. Bear in mind that lichens grow more slowly than most plants; freshly disturbed or recently eroded areas and areas lacking woody substrates or covered by fast-growing annuals, especially grasses, are likely to be lichen-poor.

Making Connections

This lesson is the first of all of the lessons because it prepares the teacher and students to engage in more active uses of lichen knowledge by building a vocabulary of terms and concepts basic to lichens. Once the class understands basics morphology as taught in this lesson, they can proceed to collecting and identifying lichens lesson plans. These in turn, prepare students to try the more difficult lesson plans dealing with monitoring atmospheric changes with lichens and more.

Check for Understanding

1. Did you see the layers of the lichen when it was cut or broken in half?
2. How can you tell the medulla from the photobiont layer?
3. What is the difference between a lichen and a vascular plant?
4. What two (or three) organisms form lichen?
5. How do the two organisms interact?
6. How can a lichen attach to its substrate?
7. In your activity, what part of the lichen did you label thallus? Medulla?
8. Name and describe the some major structures of lichen.

**See 'Additional Resources and References' page
for more information.**