Advanced Botany For Eleventh Grade

Fungi and Lichen Introduction and Guide

The goal of this block is to introduce you, the student, to fungi and help you learn how to identify different fungi in their region and others. During this process you will develop and expanded vocabulary for learning the parts of a mushroom as well as words used in identifying fungi. Another goal we have for you is to expand your ability as a citizen scientist and to be able to gain more practice in the area of identifying living organisms in any realm through closer observation, expanded vocabulary and increased awareness.

This class consists of the following lessons:

1. Lesson One: Read this introduction and do the assignments
2. Listen to the lecture on Fungi by instructor Kristie Burns. You will not do an assignment after this lecture. You will use this information to complete your final assignment which is described in the section called “Student Mushroom Handbook: Part 5”
3. Read the book, “Fungi and Mushrooms of Iowa” and do the assignment
4. Read Student Mushroom Handbook: Part 1 and do the assignment
5. Read Student Mushroom Handbook: Part 2 and do the assignment
6. Read Student Mushroom Handbook: Part 3 and do the assignment
7. Read Student Mushroom Handbook: Part 4 and do the assignment
8. Read Student Mushroom Handbook: Part 5 and do the assignment

There is a lot of information in the world of fungi and a lot of new terms. Don’t be worried by all the scientific terms. Understanding fungi is actually very easy once you start to learn about their shapes, colors and small differences. To help you get off to a good start I have provided a short overview below. The video you will watch next will also help you ease into the “more intense” reading.

What are Fungi?

Fungi are living organisms that are distantly related to plants, and more closely related to animals, but rather different from either of those groups.
Fungi can be recognized by the following five characteristics:

(1) The cells of fungi contain nuclei with chromosomes (like plants and animals, but unlike bacteria).

(2) Fungi cannot photosynthesize (they are heterotrophic, like animals)

(3) They usually reproduce by means of spores, which develop on, and are released by, a range of unique structures (such as mushrooms, cup fungi, and many other kinds of microscopically small fruiting bodies).
(4) Fungi absorb their food and spread a network of tubular branching filaments that exude enzymes and absorb food.

What are Lichen?

I will talk about the topic of **lichens** because they're a type of **fungus**. However, they are unlike a "normal" **fungus** because a **lichen** can't exist without algae or cyanobacteria. In addition, recent discoveries have shown they may be reclassified altogether.

Lichens must surely be the most neglected members of the Plant Kingdom. Yet they may be found all over the world, from the Antarctic continent to the tropics, in habitats ranging from spray-washed rocks by the sea, to boulders at the edge of the snow-line on mountains; from rain forests to deserts. In harsh, inhospitable environments they may be the only vegetation, and they are almost invariably the first colonizers of exposed rock surfaces. The only places where lichens are unlikely to be found is in or near cities, as they are very sensitive to atmospheric pollution by smoke or fumes.

Most people know lichens as those flaky, light green things that grow on tree bark, and learned in school that they're a mutually beneficial partnership or "symbiosis" between fungi and algae. But lichen scientists have made the shocking new discovery that many lichens are also made up of a previously undiscovered third partner — a new kind of yeast. Not only does that potentially alter the fundamental definition of what a lichen is, but it "should change expectations about the diversity and ubiquity" of the organisms that form them.

The new yeast has apparently gone undetected in lichens for more than a century, despite the fact that scientists all over the world have devoted entire

careers to studying lichens closely with microscopes and genetic testing. That seemed so unlikely that the scientists working on the project had trouble believing it themselves.

Traditional DNA analysis relies on probes or lures to fish out certain characteristic regions of genetic material, partly based on what scientists expect to find — like calling out names in a dark room to see who's there, Spribille said. “Newer techniques instead look for all genes that are in the process of being translated into proteins via "messenger" molecules called RNA. Spribille likens the technique to turning on the lights.”

McCutcheon says that gives a sense of what an organism is doing at any given time. To the researchers' surprise, the RNA they found came not just from the fungus and the alga known to be associated with the lichens, but a mysterious third organism. Further analysis showed it to be a new kind of yeast, belonging to the taxonomic group Basidiomycota, the same one that button mushrooms belong to. It was not at all related to the yeasts used to brew beer or bake bread. Yeast cells and DNA were extremely common in the yellow, poisonous lichen, but rare in the edible brown lichen.

"It's all very exciting to me," he added. "If Toby's idea proves to be correct, this is the second really major finding that changes how we see these organisms" — after the 1860s discovery that lichens weren't one organism, but made of two separate organisms, an alga and a fungus.

Lichen identification most often is determined by the descriptive appearance, size, shape and color of the lichen body and the reproductive characteristics. Lichens are placed in groups based on their body forms and features. The three main body groupings are crustose (crust-like,), foliose (leaf-like, seen above), and fruticose (tube or beard-like strands). This is another reason I highly recommend getting started with your wildlife adventures by finding and identifying fungi and lichen. After studying animals, plants and now fungi I can tell you that animals do not stay in one place like fungi do and plants have so many categories it will make your head spin. I once went to a DNR two-day conference on plants where we spent hours just identifying kinds of grasses!

What are Mosses?

Mosses *are* plants. They're typically soft and grow in dark, damp places like a rock in an intermittent stream or on the floor of a damp wooded area. One good way to describe a moss is like a green mat that you might place on your porch.

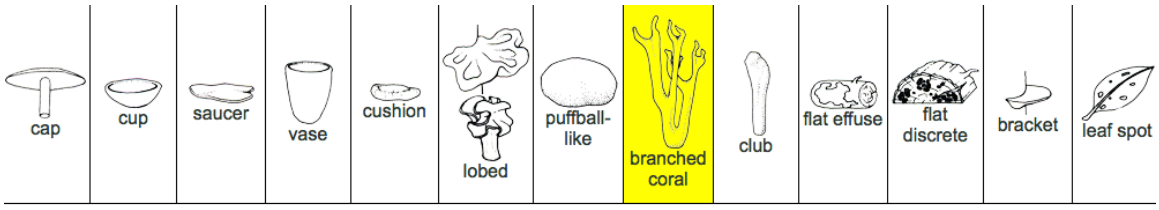
Even though mosses make their own food through photosynthesis like other plants, they do not have flowers or seeds. Instead, they send out spores or can reproduce when one part of the moss breaks off and lands in an appropriate place for growth.

How Do We Organize Mushrooms?

It may surprise you to know that there is no "one way" to organize fungi. We always think of science as a conclusive sort of method that has specific rules but in reality it is a way of organizing the world with specific methods that are always being updated according to new information. AND the way the world is organized may differ depending on what your goals or visions are as a scientist.

However, of all the methods (and you will read about more in the student handbook) I have chosen the shape method to be the most suitable for the citizen scientist/student. This is the method we will be using.

In the video you will watch you will see a poster. That poster is organized by type. I will also show you a book that is organized by scientific category. The apps I will show you also organize by scientific name and category but they use different categories. These are the different shapes we can organize mushrooms by:



Within these categories you also need to be familiar with the parts of the mushroom. You will find these parts (such as the gills) illustrated in the upcoming picture "Life Cycle of Fungi"

Further Reading on Lichen

There is a new discovery in the world of Lichen that reveals that we have been studying and possibly even classifying lichen incorrectly for about 100 years and provides exciting insight into how lichen form.

You can read more about the lichen study here if you are interested: http://www.cbc.ca/news/technology/lichen-yeast-1.3689468

I have also included the article below…

Most people know lichens as those flaky, light green things that grow on tree bark, and learned in school that they're a mutually beneficial partnership or "symbiosis" between fungi and algae.

But lichen scientists have made the shocking new discovery that many lichens are also made up of a previously undiscovered third partner — a new kind of yeast.

Not only does that potentially alter the fundamental definition of what a lichen is, but it "should change expectations about the diversity and ubiquity" of the organisms that form them, says a new study published Thursday in Science.

The new yeast has apparently gone undetected in lichens for more than a century, despite the fact that scientists all over the world have devoted entire careers to studying lichens closely with microscopes and genetic testing.
That seemed so unlikely that the scientists working on the project had trouble believing it themselves.

"It's so surprising that you kind of doubt yourself for a long time," said John McCutcheon, a microbiologist at the University of Montana and a research fellow with the Canadian Institute for Advanced Research who co-authored the new study published today in Science.
"We had to check our data more than 10 times," recalled Toby Spribille, lead author of the paper. "It seemed to me so unlikely that so many people would have missed that."

Spribille, a University of Montana botanist who first started studying lichens in British Columbia 15 years ago, was inspired by a mystery flagged by B.C. lichenologist Trevor Goward in a series of essays.

It concerned two lichens that grow in B.C. and Montana and considered separate species for 100 years. One called wila or edible horsehair lichen, also known by the scientific name *Bryoria fremontii*, is a brown-coloured lichen that was an important traditional food for many First Nations in northwestern North America.

The other, called tortured horsehair lichen or *Bryoria tortuosa*, is yellow and poisonous. However, a recent genetic analysis showed that they were genetically identical — they were made up of exactly the same species of fungus and the same species of algae.

"There's something really weird about that," Spribille said.

He brought the problem up with McCutcheon, an expert in new, sophisticated genetic techniques that he typically uses to study insects.

Traditional DNA analysis relies on probes or lures to fish out certain characteristic regions of genetic material, partly based on what scientists expect to find — like calling out names in a dark room to see who's there, Spribille said.

Newer techniques instead look for all genes that are in the process of being translated into proteins via "messenger" molecules called RNA. Spribille likens the technique to turning on the lights.

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Further analysis showed it to be a new kind of yeast, belonging to the taxonomic group Basidiomycota, the same one that button mushrooms belong to. It was not at all related to the yeasts used to brew beer or bake bread. Yeast cells and DNA were extremely common in the yellow, poisonous lichen, but rare in the edible brown lichen.

After running the experiment enough times to convince themselves the signal wasn't due to contamination and pinpointing the yeast cells in the outer skin of the lichen, the researchers decided to see whether other lichens from around the world also contained the yeast. Sure enough, many did.

"Each lichen has a specific strain of the yeast," McCutcheon said. "These form several new fungal families."

DNA analysis suggests the yeast has been part of lichens for more than 100 million years — since the end of the Early Cretaceous, when dinosaurs like spinosaurus and allosaurus roamed the Earth, and flowering plants first appeared.

Spribille said the discovery "seriously challenges" a lot of assumptions that have been held by lichenologists for a century.

"At the next level up, it gives us insight into how one of the most fascinating symbioses works."

'Really major finding'
Goward, whose essay inspired the research, said he was delighted by the discovery.

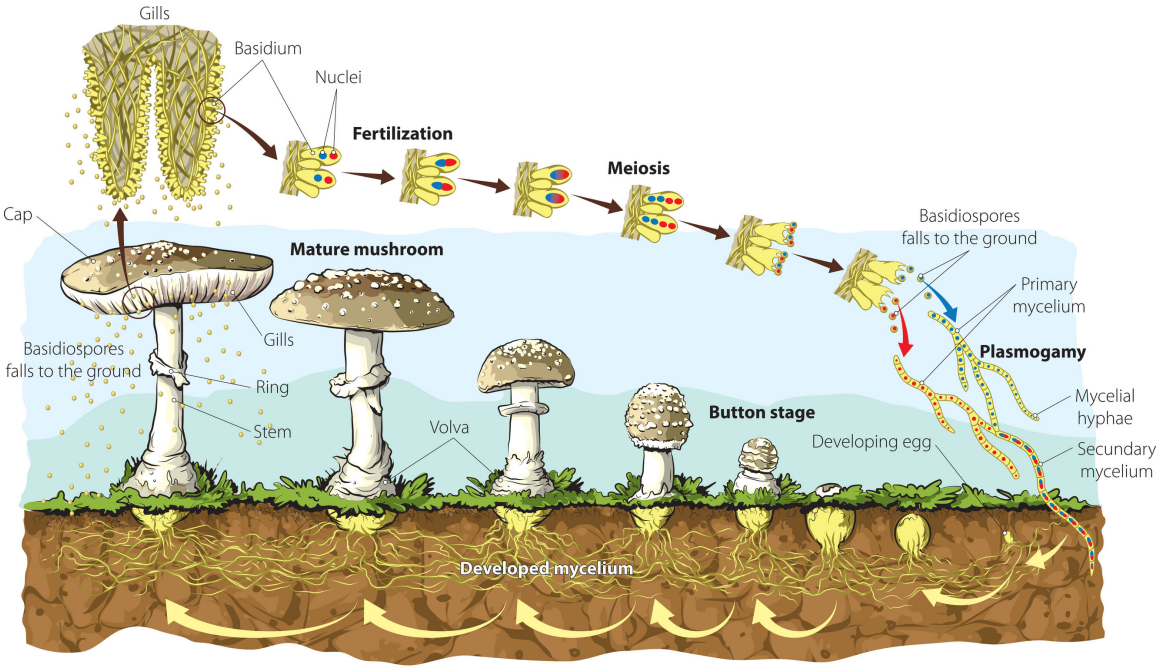
"It's all very exciting to me," he added. "If Toby's idea proves to be correct, this is the second really major finding that changes how we see these organisms" — after the 1860s discovery that lichens weren't one organism, but made of two separate organisms, an alga and a fungus.

Irwin Brodo, an emeritus scientist at the Canadian Museum of Nature in Ottawa who has devoted himself to the study of lichens for decades, said the discovery was "plausible" but "not proven yet."

Brodo, who first gave the horsehair lichens the name Bryoria, said he was surprised that the new yeast cells were discovered in a part of the lichen that a lot of lichenologists, including himself, have examined carefully.
"I never saw them," he said.

But he added that the presence of the yeast might also explain other longstanding mysteries about other lichens that look very different but have been found to be genetically identical.

The Life Cycle of Fungi



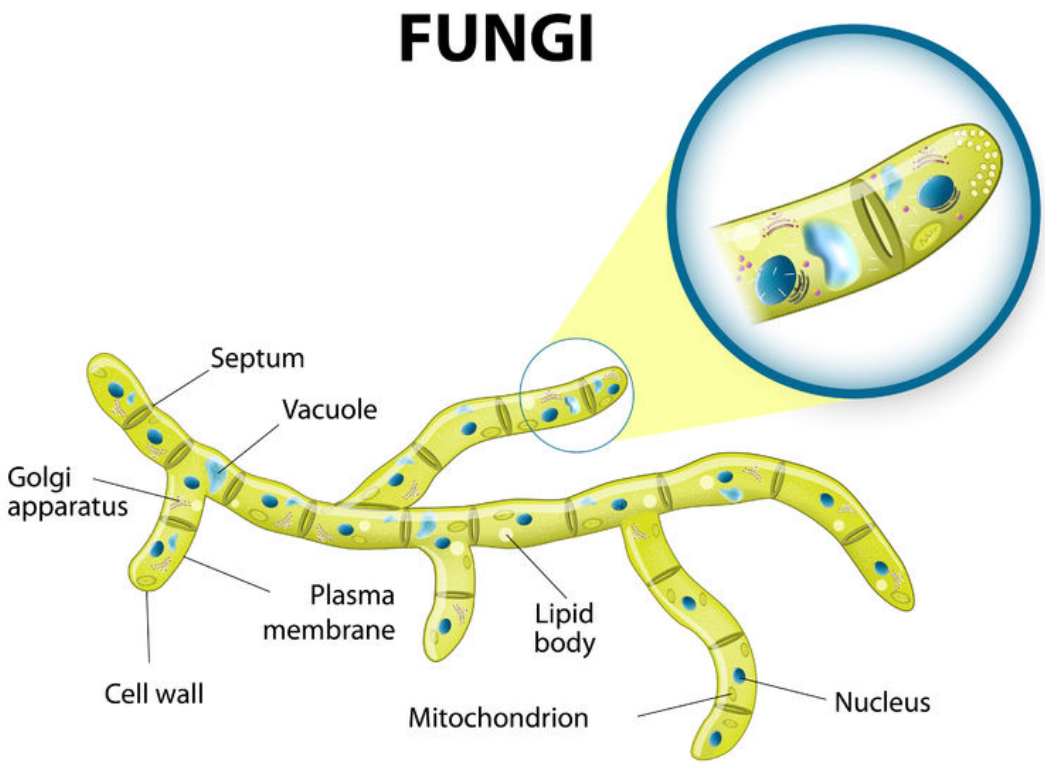
Amanita pantherina

Musroom Lifecycle Image from RTF123 by Lukaves Number 48879205

As you are hunting for mushrooms try to identify which stage your “found” mushroom is in according to this chart.

The Cells of Fungi

We will talk more about cells later in a block called “Cell Biology”. For now, you can become familiar with the basic cell structure of fungi using the drawing below.



Cells of Fungi by Designua at rtf123 36477181