

The **fungus** FILES

**AN EDUCATOR'S GUIDE TO FUNGI
K-6**

SECOND EDITION



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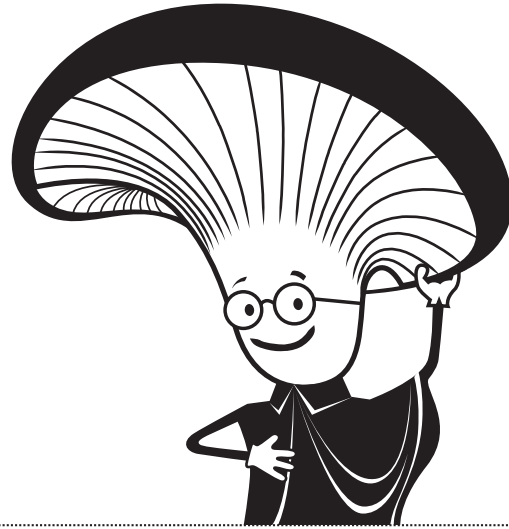
With sincere appreciation,

terraBrie Stewart, B.Sc.



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Introduction

Throughout history, fungi have been regarded with great suspicion. The ancients, wary of mushrooms that appeared like magic after a heavy rain, called them 'a callosity of the earth', 'earthly excrescences', and 'the evil ferment of the earth'. In spite of leaving a bad first impression, these peculiar entities are subjects of great curiosity. The strange talents of fungi include the ability to luminesce; their greater similarities to insects than to plants; and the tendency to grow in fantastical fairy rings. These are only a few ways these bedazzling organisms can launch a child's imagination into overdrive. However, what is truly relevant about fungi is the way that they encourage ecological thinking by illustrating the delicate interconnectedness of all living and non-living things.

GETTING STARTED

Here are a few recommendations to consider in preparation for the activities presented in this guide:

- **DO** become acquainted with the whole guide, as many activities are complementary.
- **DO** collect a variety of mushroom picture books and field guides and/or posters before commencing fungal studies. There is a great series of posters created by David Arora available for sale online (see Suggested Resources and Sources, page 91)
- **DO** familiarize yourself with basic fungal vocabulary; a glossary can be found at the end of this guide. For example, "fungus" and "mushroom" are often used interchangeably but you need to recognize that there is a distinction: **mushroom** generally refers to just the fruiting body or reproductive part of the organism whereas the term **fungus** encompasses the entire organism. Similarly, **hyphae** (sg. hypha) are the threads that make up the fungal body; collectively, the hyphae are called the **mycelium** (pl. mycelia).
- **DO NOT** be intimidated by the depth of the background information. It is simply meant to provide a comprehensive overview of the Kingdom Fungi and certainly not all of the information is necessary to provide a stimulating introduction to your students.

INTRODUCTION

FORMAT

This educator's guide explores the world of fungi through worksheet activities, hands-on activities, and classroom demonstrations. It is divided into five sections, each containing a set of activities relating to the main topic.

INTRODUCTION

An overview of topics discussed in the guide are presented in the introduction-- this includes what constitutes the fungal kingdom; the diversity of forms; and their ecological roles. Students will also become aware of just how prevalent (though hidden!) fungi are in their everyday environments.

BIOLOGY AND CLASSIFICATION

In this chapter, students will learn what separates the fungi from the plants and the animals; the basics of anatomy; and the use of dichotomous keys for identification purposes.

REPRODUCTION AND DEVELOPMENT

The purpose of this chapter is to develop an appreciation of fungal life cycles. The non-fleshy fungi, in particular moulds and yeasts, will be explored in detail. Students are also introduced to some of the unique ways fungi disperse their spores into the environment.

ADAPTATION AND ENVIRONMENT

This chapter emphasizes the concept of mycorrhizas and other symbiotic relationships. To a lesser degree, the role of fungi in nutrient recycling and soil creation are also addressed.

FUNGUS AMONG US

This chapter examines our relationship with fungi throughout the centuries, which includes topics such as folklore and mythology. A major activity gets students outside for a mushroom hunt. In doing this, students will also become familiar with field guides as tools for mushroom identification. Finally, the ecological impacts of a variety of human activities are discussed.

The activities will be divided into

- **Objective:** States the theme and objective of the activity.
- **Grades:** Grade level of the approximate target audience.
- **Type of Activity:** Teacher read/comprehension, Crosswords, Observation puzzle, etc.
- **Materials:** Materials required to complete the activity.
- **Vocabulary:** Specific terminology students may not be familiar with; it is a good idea to review these words before starting the activity. Definitions for these words can be found in the glossary.
- **Background Information:** This section provides additional information that prepares the educator for questions that may arise. More complete background text can be found at the beginning of each section.
- **Teacher Instructions:** Step by step instructions that guide the educator through the activity.
- **Extensions:** Suggested ways to expand upon the presented activities.

Although a list of discussion topics does not always accompany the activities, it is recommended before starting an exercise that the students are given a chance to express themselves by either asking questions or sharing relevant experiences on subject matter pertaining to the activity.

Fungi—The Hidden Kingdom

OBJECTIVE

- To provide students with basic knowledge about fungi

BACKGROUND INFORMATION

The following text provides an introduction to the fungi. It is written with the intention of sparking curiosity about this fascinating biological kingdom.

TEACHER INSTRUCTIONS

- With your class, brainstorm everything you know about fungi.
- For younger students, hand out the question sheet before you begin the teacher read and have them follow along and answer the questions as you read.
- For older students, inform them that they will be given a brainteaser quiz (that is not for evaluation) after you finish reading the text.
- The class can work on the questions with partners or in groups and then go over the answers as a class. Discuss any particularly interesting facts and encourage further independent research.

K-3 ADAPTATION

- To introduce younger students to fungi, you can make a KWL chart either as a class or individually. A KWL chart is divided into three parts. The first tells what a student KNOWS (K) about a subject before it is studied in class. The second part tells what the student WANTS (W) to know about that subject. The third part tells what the child LEARNED (L) after studying that subject.
- Share some of the fascinating fungal facts presented in the “Fungi—The Hidden Kingdom” text with your students.

COMPREHENSION QUIZ ANSWER KEY

- A. 1.F; 2.T; 3.F; 4.T; 5.T; 6.F; 7.T
 B. **wheat**
 C. **1 500 000**
 D. **tin cans**
 E. **roots**
 F. **all of these;**
 G. **Irish potato famine**
 H. **recycling**
 I. **mowing the lawn**

Activity 0.1



GRADES

4-6 with a K-3 adaptation

TYPE OF ACTIVITY

Teacher read/comprehension

MATERIALS

- copies of page 11
- pencils

VOCABULARY

bioremediation
 chitin
 fungi
 habitat
 hyphae
 kingdom
 lichens
 moulds
 mushrooms
 mycelium
 mycorrhizas
 nematodes
 parasitic fungi
 photosynthesis
 protozoan
 rusts and smuts
 saprophytic fungi
 seed
 spore
 symbiotic fungi
 yeasts

Fungi—The Hidden Kingdom

Have you ever played the question game “Animal, Mineral or Vegetable”? If so, choosing a mushroom as the answer would be sure to confuse people. Most people think of mushrooms as vegetables but this is really not true! These tricky organisms are actually **fungi** (**fungus** sing.) and are as different from plants as plants are from animals—in fact they are actually more like us than they are like cucumbers!

MUSHROOM, FUNGI...WHAT’S THE DIFFERENCE?

Before we really start to talk about fungi, we should set something straight. There is far more to fungi than just mushrooms. The word “fungi” is used to describe a classification or **kingdom** of organisms (plants and animals each have their own kingdom). Members of the Kingdom Fungi are not able to make their own food. A mushroom is only a very small part of a much bigger organism, the fungal body or **mycelium**. The mushroom is the fruit of a fungus much like an apple is the fruit of an apple tree. Fungi also love to play hide and seek and they often hide underground. This is one reason why fungi have been called “the hidden kingdom”.

There are many type of fungi that do not produce mushrooms. Fungi also include **yeasts** (that make bread light and fluffy), **moulds** (that we find on old bread and on fruits and vegetables), **rusts and smuts** (that cause damage to agricultural crops) as well as many other forms that give us medicines or cause us discomforts like athlete’s foot and ringworm.

DID YOU KNOW...

that for every person on earth there are approximately 2 tonnes of fungi? That means for every person in your class there is a hippopotamus’ weight worth of fungi! Experts estimate that there may be as many as 1.5 million species of fungi. However, only a small fraction have been described and even fewer of these produce mushrooms. This means there are more fungi than most other types of organism -- and fungi aren’t spring chickens either! The oldest fossil fungus found dates back 545 million years old, which is a long time before flowering plants appeared on the earth.

FOLKLORE FANCY

Fungi have also been a source of mystery and folklore for thousands of years. Many ancient people believed that mushrooms were formed when bolts of lightning hit the ground. Other people thought they were created by witches or evil spirits and you could catch a disease just by touching them! Others believed that “fairy rings”, which are the places where mushrooms grow in circles, were dangerous places where elves danced, toads met, or the devil set his churn at night. These ideas all seemed to come from the ability of mushrooms to “appear out of nowhere”, usually after a rainstorm. We now understand that the fungus was there all along and the moisture of rain encouraged the mycelium to produce its fruit.

SURPRISE! MUSHROOMS ARE NOT PLANTS!

Until fairly recently scientists considered fungi to be a type of non-flowering plant, but there are three main differences between plants and fungi. First, plants are able to make their own food using sunlight through a process called **photosynthesis** whereas fungi need to get their food from another source. There are three main ways that they can do this: they can get their nutrition by breaking down dead material like leaves and wood; these fungi are called **saprobic** fungi. They can also get their energy from another living thing like an insect, plant or animal. This type of fungus is what causes diseases such as athlete's foot and they are called **parasitic** fungi. Finally, fungi can get their food by cooperating with other species such as trees or **algae**. These are called **symbiotic** fungi and are very common. You might recognize **lichens** as one type of symbiotic fungi; you can find lichens growing on bark, and very extreme places such as in the Arctic or even on rocks.

There is another big difference between plants and fungi. Plants reproduce using **seeds**. Seeds contain many cells which make up an embryonic plant plus a food supply. This means that when a seed lands in a good **habitat**, it can use its own "packed lunch" as energy to begin to grow. Fungi reproduce using **spores**. Spores are different from seeds because they are often only a single cell and do not contain much stored energy. This means they need to land on a good food source (like that fruit that has been on the counter too long) before it can start to grow. Once the spore sprouts or germinates, it grows into tiny threads called **hyphae**. Once these threads get numerous enough, they will collectively be called the **mycelium**. A mushroom is actually made up of a whole bunch of tightly packed hyphae.

Finally, plants have cell walls made of cellulose whereas fungi have cells walls made of **chitin**. Chitin is the hardest biologically made substance on Earth. Chitin also forms the hard shells of many insects. It also protects spores from harm before it is time for them to start to grow. Some scientists suspect that mushroom spores are capable of space travel; a few even believe that some fungi found on Earth originally came from outer space! What do you think about this idea?

MORE THAN JUST A MUSHROOM?

As you might have already guessed, there is a much bigger variety of mushrooms out there than the little umbrella-shaped ones you see at the grocery store. Mushrooms can look like a mini bird's nest, coral from the ocean floor, an octopus, balls of lace, little brown brains, orange peels, shelves on a tree trunk, or even like big white soccer balls. They come in virtually every colour of the rainbow too. Some fungi even have the ability to glow-in-the dark! Imagine that!

I bet you are surprised to learn that there also predatory fungi that trap small worms called **nematodes**. The fungi will set a variety of booby-traps or snares and then at the right moment, SNAP the worm is trapped and the fungus begins to digest the worm from the inside until all that remains is the skin.

FUNGUS HUMONGOUS

Would you believe that some mushrooms called Giant Puffballs have been known to grow so big as to be mistaken for sheep? In Michigan, USA, another type of fungus mycelium was found to cover an area equal to 212 football fields and weigh as much as a blue whale. Not only is this fungus thought to be among the largest living organisms on earth, but it is also believed to be 1500 years old!

INTRODUCTION

FUNGI AROUND THE WORLD AND ACROSS TIME

Fungi are found all over the world in fields and forests, hot deserts and dry Arctic lands—they have even been found on Antarctica. In many countries, mushroom hunting is a national pastime and wild mushrooms are considered a delicacy or excellent source of natural medicine. The prehistoric Iceman “Ötzi”, who is thought to have lived 5000-5500 years ago, had two different types of fungi with him; one was a type of fungus used to help get a fire started, and the other was threaded onto a leather thong and is believed to have been used medicinally as an antiseptic.

FUNGI AS FRIEND AND FOE

Over time fungi have developed a bad reputation as being the cause of much death and destruction. One example of a tragedy caused by fungi is the Irish Potato Famine. In the 1840s, a fungal parasite destroyed the potato crops causing 1 million deaths and a mass emigration to North America. Nowadays, fungi are responsible for the failure of 1/8 of the world's crops. In our homes fungi can spoil fruit, bread and other food; destroy clothing and books; cause allergic reactions; or make us or our pets very sick.

So now that we have seen the dark side of this kingdom, let's look at the ways in which fungi are our friends. The most important role fungi play in the environment is that they are the Masters of Recycling. Fungi, along with bacteria and **protozoans** (another kingdom), compost plants after they die and transform them into rich soil. If not for fungi, the Earth would soon be buried in metres of debris and life on the planet would soon disappear.

Another important job fungi have is as **mycorrhizas**. Mycorrhizas literally means “fungal roots”. Fungi wrap themselves around the roots of a plant and, like a long drinking straw, suck nutrients from the soil to give to the plant; in exchange, the plant gives the fungi sugar. Up to 95% of land plants rely on mycorrhizas for healthy growth, so it is a very popular arrangement in nature. Scientists are now using mycorrhizas to help with the health of the baby trees planted in reforestation.

NOW ON TO SOMETHING APPETIZING...

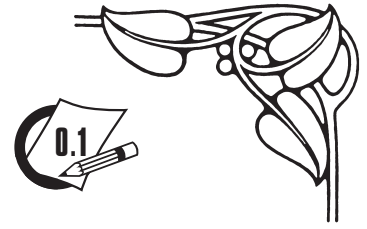
If you don't like to eat mushrooms, you might think it wouldn't be a big deal if we lived in a world without fungi. However, as we said earlier, fungi are far more than just the mushrooms on your plate. Fungi also are essential in making breads; certain types of cheese; wine, beer and other alcoholic beverages; soy sauce; and even adding flavour to your favourite soda pop. Mushrooms themselves also contain essential minerals and vitamins. As well, some fungi are also used to make antibiotics such as penicillin that have saved many lives.

We've already talked about how mushrooms are useful as food and medicine but now research is being done using fungi in something called **bioremediation**. What this means is that fungi are being used to absorb and digest dangerous substances like oil, pesticides and industrial waste in places where they threaten the environment. Other research is being done to see how fungi can help control insects that destroy food crops.

Fungi are so much more than just mushrooms. They are a fascinating and charismatic kingdom that is woven into every part of our environment. As humans, we depend on them day in and day out for our very existence. So let's all take a closer look and begin to discover the fungus among us!



How Mouldy is Your Memory?



A

TRUE OR FALSE?

- | | | |
|-----------------------|-----------------------|--|
| <input type="radio"/> | <input type="radio"/> | 1. Mushrooms are a type of vegetable. |
| <input type="radio"/> | <input type="radio"/> | 2. The scientific word for the fungal body is "mycelium". |
| <input type="radio"/> | <input type="radio"/> | 3. Fungi use photosynthesis to make their own food. |
| <input type="radio"/> | <input type="radio"/> | 4. Some fungi are able to glow-in-the dark. |
| <input type="radio"/> | <input type="radio"/> | 5. Some fungi trap worms for their food. |
| <input type="radio"/> | <input type="radio"/> | 6. 5% of plants rely on "fungal roots" to help them grow. |
| <input type="radio"/> | <input type="radio"/> | 7. Prehistoric humans may have used fungi to help start fires. |

B

WHICH OF THESE IS NOT A TYPE OF FUNGUS?

- | | | | |
|-----------------------------|------------------------------|------------------------------|-------------------------------------|
| <input type="radio"/> wheat | <input type="radio"/> yeasts | <input type="radio"/> moulds | <input type="radio"/> rusts & smuts |
|-----------------------------|------------------------------|------------------------------|-------------------------------------|

C

HOW MANY SPECIES OF FUNGI ARE THERE IN THE WORLD?

- | | | | |
|---------------------------|----------------------------|------------------------------|---------------------------------|
| <input type="radio"/> 150 | <input type="radio"/> 1500 | <input type="radio"/> 15 000 | <input type="radio"/> 1 500 000 |
|---------------------------|----------------------------|------------------------------|---------------------------------|

D

WHICH OF THESE IS NOT FOOD FOR FUNGI?

- | | | | |
|-----------------------------------|--------------------------------|--------------------------------|-----------------------------|
| <input type="radio"/> dead leaves | <input type="radio"/> tin cans | <input type="radio"/> our feet | <input type="radio"/> trees |
|-----------------------------------|--------------------------------|--------------------------------|-----------------------------|

E

WHICH IS OF THESE IS NOT PART OF A FUNGUS?

- | | | | |
|--------------------------------|------------------------------|-----------------------------|------------------------------|
| <input type="radio"/> mycelium | <input type="radio"/> hyphae | <input type="radio"/> roots | <input type="radio"/> spores |
|--------------------------------|------------------------------|-----------------------------|------------------------------|

F

WHAT CAN MUSHROOMS LOOK LIKE?

- | | | | |
|------------------------------------|-----------------------------------|-------------------------------------|------------------------------------|
| <input type="radio"/> orange peels | <input type="radio"/> ocean coral | <input type="radio"/> a bird's nest | <input type="radio"/> all of these |
|------------------------------------|-----------------------------------|-------------------------------------|------------------------------------|

G

WHAT MAJOR TRAGEDY WAS CAUSED BY A FUNGUS?

- | | | | |
|---------------------------------------|--|---|------------------------------------|
| <input type="radio"/> sinking Titanic | <input type="radio"/> sinking Atlantis | <input type="radio"/> Irish potato famine | <input type="radio"/> World War II |
|---------------------------------------|--|---|------------------------------------|

H

WHAT IS THE MOST IMPORTANT JOB OF THE FUNGI IN THE ENVIRONMENT?

- | | | | |
|----------------------------------|--------------------------------------|--|---------------------------------|
| <input type="radio"/> being food | <input type="radio"/> looking pretty | <input type="radio"/> killing crop pests | <input type="radio"/> recycling |
|----------------------------------|--------------------------------------|--|---------------------------------|

I

WHICH OF THESE IS NOT A USE FOR FUNGI?

- | | | | |
|--------------------------------|--|---|---------------------------------------|
| <input type="radio"/> medicine | <input type="radio"/> cleaning the environment | <input type="radio"/> helping plants grow | <input type="radio"/> mowing the lawn |
|--------------------------------|--|---|---------------------------------------|





Activity 0.2

GRADES

3-6 with a K-2 adaptation

TYPE OF ACTIVITY

Observation puzzle

MATERIALS

- copies of page 14
- pencils
- pencil crayons, crayons or markers

VOCABULARY

algae

citric acid

Dutch elm disease

lichens

mycorrhizal relationship

spores

It's a Fungal Jungle!

OBJECTIVE

- To introduce fungi as an intricate part of the living ecosystem and have students begin to see fungi beyond mushrooms

BACKGROUND INFORMATION

Fungi are literally all around us. Everyday we see them, walk by them or on them, eat them, and even breathe them, whether we want to or not. Invited, these fungal friends may accompany us to a family picnic on the menu--sometimes visibly such as on a pizza or as a pâté but sometimes they are more subtle. Some more subtle fungal guises are as a leavening agent in breads; the ripening agent of Brie, Camembert, Roquefort and other blue cheeses; the fermenting agent in alcoholic beverages and soy sauce; and as the precursor to the popular flavouring agent and preservative **citric acid** (commonly found in soft drinks). Both chocolate and coffee involve yeast fermentations during processing. As well, many washing powders contain fungal enzymes.

Fungi may also be seen fruiting as mushrooms near trees with which they have a **mycorrhizal** relationship. They will certainly be busy decaying the dead leaves and grass on the ground. They may also be starting to mould some fruit in the picnic basket. **Spores** will be circulating in the air. Fungi will also likely be found pairing with **algae** as **lichens** on tree bark or rocks. As well, a fungus could be actively attacking an American elm tree as **Dutch elm disease**. This list is by no means complete but it does serve as an introduction to the fungus among us!

TEACHER INSTRUCTIONS

1. Begin by asking students if they have ever invited fungi with them on a picnic (you'll probably get some laughs). Explain that at any given time, there are thousands of fungi all around us.
2. Hand out copies of page 14 to each student and ask them to find as many examples of fungi as they can in the drawing of the picnic.
3. You may encourage them to compare with a neighbour before reviewing the picture as a class and talking about the less obvious fungi that were likely missed.
4. Time permitting, students could also colour their picnic pics.

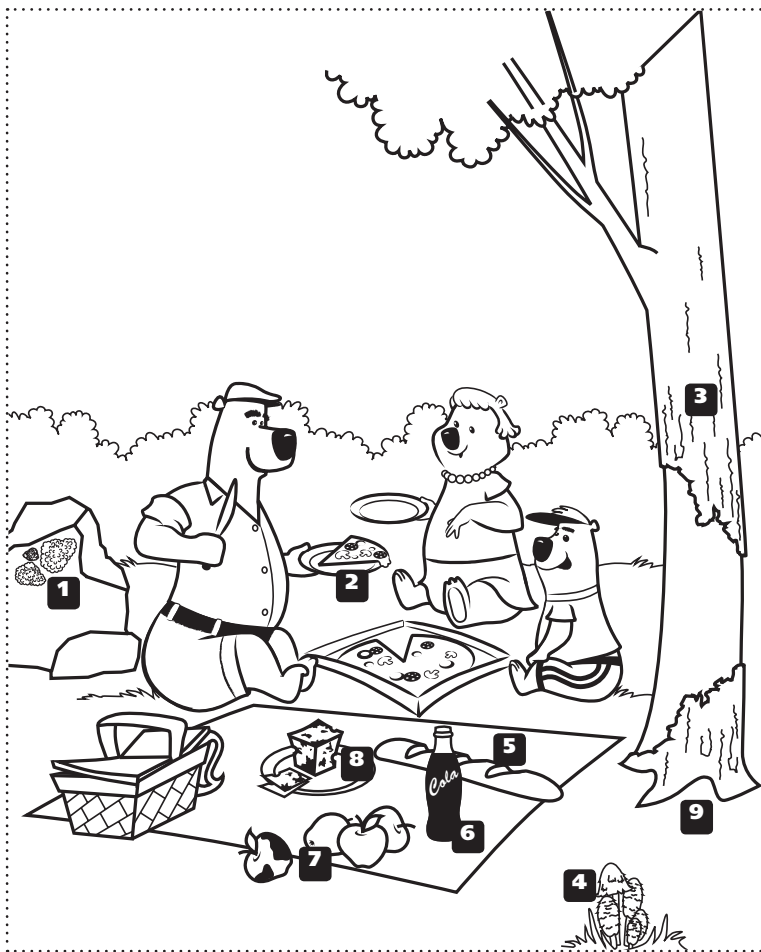
K-2 ADAPTATION

When working with younger students, you may wish to copy the picture onto a transparency and use an overhead and work through the exercise as a class. You could also hand out individual copies for the students to colour and circle the fungi.

EXTENSION

1. Bring in a stack of supermarket flyers and have students “find the fungi” and cut out items that could contain fungi or fungal products.
2. Have students find the fungi around them in their immediate surroundings, wherever that may be.

IT'S A FUNGAL JUNGLE ANSWER KEY



1. lichens (symbiotic relationship fungi and algae)
2. Mushrooms on pizza
3. Dutch elm disease
4. Shaggy mane mushrooms
5. Yeast in bread
6. Citric acid flavouring in cola
7. Mould on apple
8. Ripening agent in cheese
9. Mycelium hidden underground

Other invisible possibilities:

- decay of old leaves and grass;
- mycorrhizas with tree or other plants
- spores floating in air
- clothing dyes
- athlete's foot



Directions ▶

Fungi are all around us! Find and circle as many different examples of fungi you can.

