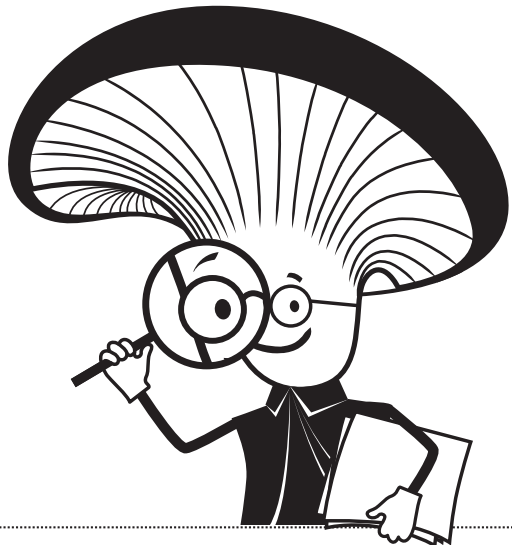


Biology and Classification

Fungi have been erroneously classified as "non-flowering plants" for most of scientific history. However, fungi hold many distinct characteristics that set them aside from the green plants:

- Fungi lack **chlorophyll**, which is an essential component for the process of **photosynthesis**.
- Unlike plants, fungi cannot make their own food and must obtain their nutrition from an exterior source. In essence fungi have their stomachs on the "outside" of their body—**enzymes** ooze out of their body onto their food and then they absorb the simpler compounds—much like a fly.
- Many fungi can live underground or in darkness which is impossible for sunlight-dependent plants.
- Fungi retain a relatively simple and uniform body composed of **hyphae** that give rise to single-celled **spores** whereas plants typically differentiate their form into roots, stems, leaves and flowers, which will produce multi-cellular **seeds**.
- The primary energy storage compound of fungi is **glycogen** (which is also what animals use!) where in plants, it is **starch**.
- The structural component in the cell walls of fungi is heavy duty **chitin**; in plants it's **cellulose**.

CLASSIFICATION

Classification systems are the scientific interpretation of organization in nature. The taxonomic system is hierarchal with *kingdom* as the highest and broadest rank and *species* as the lowest and most specific:

Kingdom The seven* kingdoms are the Animals, Plants, Fungi (**Eumycota**), Protists, Chromists, Eubacteria and Archaebacteria. Some fungus-like organisms including the amorphous slime moulds, water moulds and some parasitic fungi are now classified with the Protists and Chromists.

*It should be noted that the current classification system is always subject to review and revisions. Within any given scientific community, there is always debate in regard to the grouping of organisms; after all, these are clearly defined man-made impositions into a natural world that is constantly evolving completely oblivious to these guidelines and regulations.

Phylum/Division There are currently several phyla of true fungi: the three best known being the Zygomycota which includes the bread moulds and the Ascomycota and the Basidiomycota.

Class The Ascomycota are broken into six classes, many of which are microscopic and the Basidiomycota are broken into three classes (see table below).

Order Classes are divided in orders. All order names end in "-ales".

Family Each order contains one or more families. All family names end in "-aceae".

Genus Each family contains at least one genus and often many genera.

Species Each genus contains species.The scientific name is made up of the genus and species name and is either italicized or underlined.e.g. *Coprinus comatus.*

GROUP	APPROXIMATE NUMBERS	TYPICAL MEMBERS	CHARACTERISTICS
Zygomycota (Yolk "joining" fungi)	~600 species	Black bread moulds, dung fungi, predatory fungi	Branched mycelium produces spores in rounded spore cases
Ascomycota (Sac fungi)	~30 000 species	Yeasts, blue and green moulds, powdery mildew, precursor of Dutch elm disease, cup fungi, morels, truffles	Single cells or mycelium; spores form in asci; "spore shooters"
Basidiomycota (Club fungi)	~25 000 species	Bracket fungi, gilled mushrooms, puffballs, stinkhorns, rusts and smuts	Mycelium produces spores on the outside of club shaped structures called basidia; "spore droppers"

ANATOMY

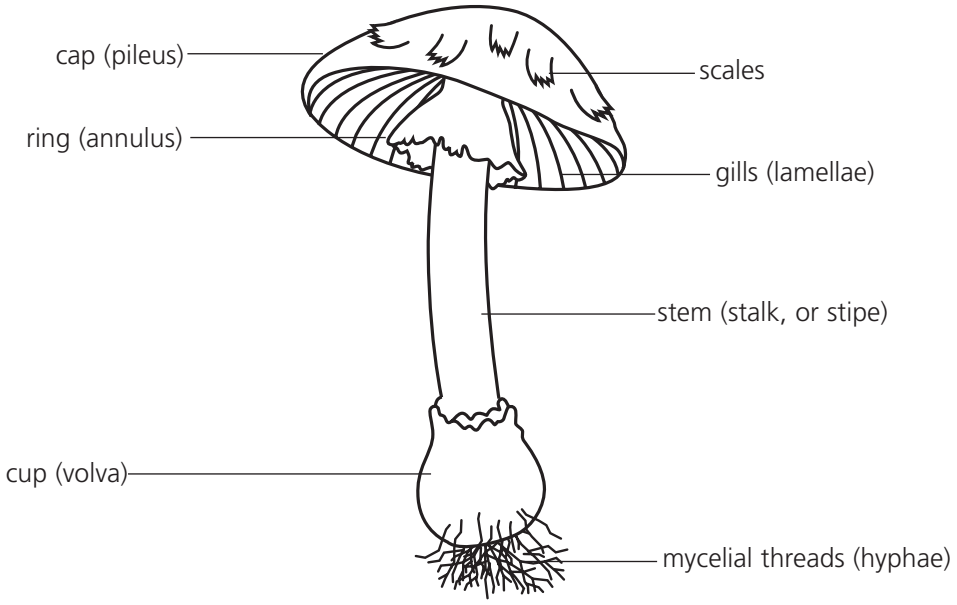


Diagram of a Generic Agaric Mushroom

When we see a mushroom, what we are really seeing is just the **fruiting body** of the much larger fungal body or **mycelium** (mycelia plur.). The mycelium is a network of filamentous, branching threads or **hyphae** (hypha sing.). Some hyphae are so thin that 20 000 of them laid side by side would only be 1 cm wide. The hyphae permeate trees, logs, stumps, or other organic material in search of food. Sometimes hyphae will form **rhizomorphs** which are tough cord-like strands that conduct food and water. The rhizomorphs of the honey mushroom can be more than as 1mm thick. The outer hyphae of the rhizomorphs are thicker with protective walls and the more delicate inner hyphae carry food and water to the fungus as it spreads.

Fruiting bodies (mushrooms) can form where two sexually compatible strains of mycelia meet. The purpose of the fruiting body is to produce and release spores into the environment. **Spore prints**, obtained by placing a mushroom cap on a piece of paper, can be an invaluable tool for identifying mushrooms. A spore print will look much like the spokes of a wheel and can vary in colour just as much as the mushrooms themselves. The typical form of a gilled mushroom is a convex pileus or **cap** which may or may not be covered in **scales**; a straight **stem** (stalk or stipe); lamellae or **gills** (or ridges, tubes or teeth in other fungi) where spores are produced; a skirt-like annulus or **ring** around the stem; and a volva or **cup** at the base of the stem. If the mushroom is dug up with some surrounding soil, some hyphae or mycelial threads should also be visible. Take note that these features are only generalizations—not all features will be present all the time on any given gilled mushroom. In fact, it is their presence or absence that help in mushroom identification.

Flora, Fauna, Fungi or Fiction?

Activity 1.1

GRADES
3-6

TYPE OF ACTIVITY
Origami Quizmaster

MATERIALS
- copies of pages 20-21
- scissors

VOCABULARY
carnivore
cellulose
chitin
herbivore
kingdom
omnivore
spores

OBJECTIVE
- To illustrate the differences between fungi, plants and animals

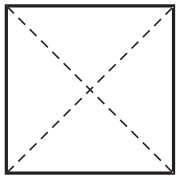
BACKGROUND INFORMATION
Fungi have long been mistaken for plants. It wasn't until fairly recently that they were assigned to their own biological classification or **kingdom**. This activity is meant to draw awareness to some of the unique features of this group of organisms. Please refer to Fungi--The Hidden Kingdom on page 8 for additional background information.

TEACHER INSTRUCTIONS
1. Begin by drawing a simple chart on the board that has the titles Flora, Fauna, Fungi, Fiction and Other. Have the students brainstorm characteristics that match each heading. If anyone lists a characteristic that does not fit in the first three, place it under the "Fiction" or the "Other" heading.
2. Hand out copies of each page to pairs of students. Make sure groups have two different sheets.
3. Construct the Origami Quizmaster. If the class is not already familiar with this technique, refer to page 19.

HOW TO PLAY QUIZMASTER Q&A
Break the group of students into pairs. One person starts with a quizmaster closed on their fingers (Student A) and the other person starts by picking a picture of a fungus from on the outside (Student B). For example, Student B may choose "Morel". Student A opens the "mouth" of the quizmaster and displays a number adjacent to the morel. In this case, the number displayed will be either 1 or 2. If 2 is shown, Student A opens the mouth in one direction and then again in the other direction to equal "2". Student B then picks another number and Student A opens the flap to reveal the question and asks it to Student B. If Student B answers correctly, he/she gets another chance to be asked a question and the above steps are repeated. When Student B answers incorrectly, it is Student A's turn to be asked a question and Student B manoeuvres the other quizmaster. The student who answers all their questions correctly first is the winner.

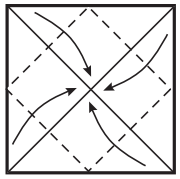
SOURCE
How to make origami diagrams was adapted from those at http://www.yasutomo.com/project/fortuneteller.html

1



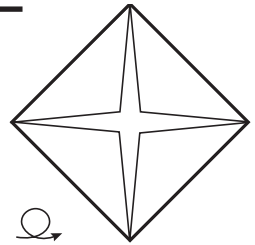
Start with a square piece of paper lying flat on the desk with the PRINT SIDE DOWN. Fold the paper in half diagonally, both ways, corner to corner.

2



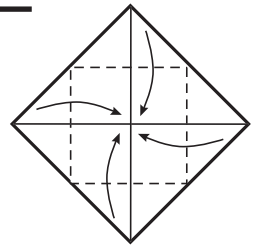
Make sure the paper is still PRINT SIDE DOWN and fold up all corners so that the points meet in the middle.

3



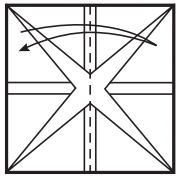
Turn the paper over so that the four flaps are facing down.

4



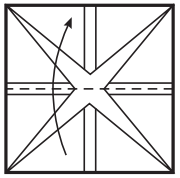
Again, fold all the corners into the centre.

5



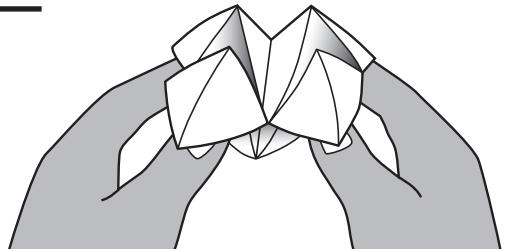
Fold paper in half and unfold.

6



Fold paper in half from top to bottom. Do not unfold.

7



Slide thumbs and forefingers under the squares to move the Quizmaster back and forth.

1
I can live off of electricity
fiction
My cell walls are made of cellulose
flora
Bolete
2
I reproduce using spores
fungi
I am the Master Recycler
fungi
Coral Fungi
7
8
I can move freely about in my environment
fauna
I get nourishment by absorbing my food
fungi
Polypore
5
6
I am mainly green
flora
Most of my body is found underground
fungi
Bird's Nest Fungi
3
4

Morel
1
I am the largest organism on earth
fungi
flora
I reproduce using seeds
8
Jelly Fungi
2
I can be a herbivore, carnivore or omnivore
fauna
flora
I can make my own food using energy from the sun
7
People used to believe I was created by lightning
fungi
fungi
My cell walls are made of chitin-- the hardest substance on earth
3
fiction
funzi
I have mastered the art of time travel
I make bread light and fluffy
6
Agaric
4
5
Earth Tongues

Shaggy Mane: Connect the Dots

Activity 1.2

GRADES
1-3

TYPE OF ACTIVITY
Connect the Dots

MATERIALS
- copies of page 23
- pencils
- pencil crayons. crayons or markers
- mushroom field guides and/or posters

VOCABULARY
habitat
spores

Scientific Classification
Kingdom: Fungi
Division: Basidiomycota
Class: Homobasidiomycetes
Order: Agaricales
Family: Agaricaceae
Genus: Coprinus
Species: *Coprinus comatus,* The Shaggy Mane or Lawyer's Wig.

OBJECTIVE
- To introduce students to a widely distributed and easily recognizable Canadian mushroom

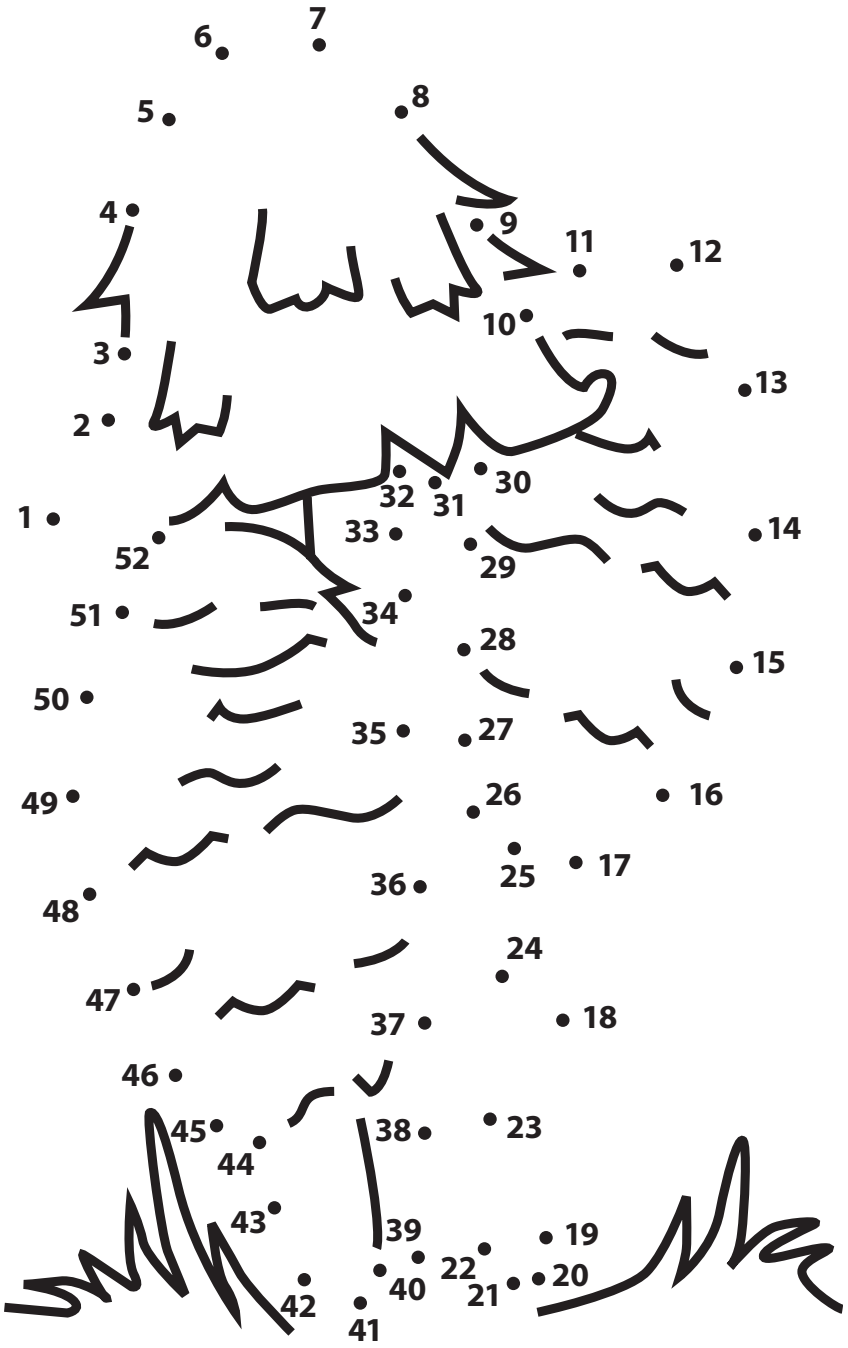
TEACHER INSTRUCTIONS
1.. Make copies of the Connect the Dots worksheet.
2. Hand them out to each student and have them connect the dots.
3. Get them to write the name of the mushroom on the blanks provided. Younger students will need help writing "SHAGGY MANE" in the blanks provided.
4. Ask the students if any of them have ever seen a shaggy mane mushroom. And if so, where was it? Explain that where something grows is called its **habitat**. Shaggy manes are known for their adaptable diets and can be found on roadsides, in meadows and fields and in city lawns from August to September.
5. Why do they think it would be called Shaggy Mane? This mushroom is also sometimes called a Lawyer's Wig. To those who know it well, this mushroom has nicknames: "Shaggie" or "Shag". It is a type of inky cap. Share with them the fact that the mushroom "melts" itself into a black, inky soup to release its **spores**.
6. Help students find pictures of the Shaggy Mane in field guides or on a poster (such as David Arora's EDIBLE FIELD, GARDEN and CULTIVATED MUSHROOMS poster) See Sources and Resources page 91.
7. Although the shaggy mane mushroom is not a colourful mushroom, you could have the students colour the mushroom any way they wish, as mushrooms can be any colour in the rainbow!

TRIVIA
One shaggy mane was so determined to grow that it was reported to have lifted a 5 kg slab of concrete!

Connect the Dots

1.2

Directions ▸ **Connect the dots and colour the picture of this INKY member of the fungal world!**



I am a _ _ _ _ _ _ _ _ _ _

Anatomical Anagrams

Activity 1.3

GRADES
3-6

TYPE OF ACTIVITY
Diagram labeling/ anagram

MATERIALS
- copies of page 25
- pencils

VOCABULARY WORDS
hyphae
mycelium
spores

OBJECTIVE
- To help students become aware of the main anatomical features of mushrooms and moulds

TEACHER INSTRUCTIONS
1. Make copies of the Anatomical Anagrams worksheet.
2. Hand them out to each student and have them unscramble the labels to complete the diagram.
3. Go over the worksheet as a class.
4. Ask students to compare and contrast the mushroom and mould. Notice that the the spores of mushrooms are found in gills. Moulds have spore cases that contain spores. In mould, the mycelium is readily visible but the vegetative (non-reproductive) mycelia of mushrooms is usually hidden in soil or decaying wood.
4. This activity complements Adventures in Yeast and Mould on page 38.

ANSWER KEY (TOP TO BOTTOM)
Mushroom
1. cap
2. ring
3. stem
4. cup
5. scales
6. gills
7. mycelium

Bread Mould
1. spore case
2. spores
3. hypha
4. bread
5. mycelium

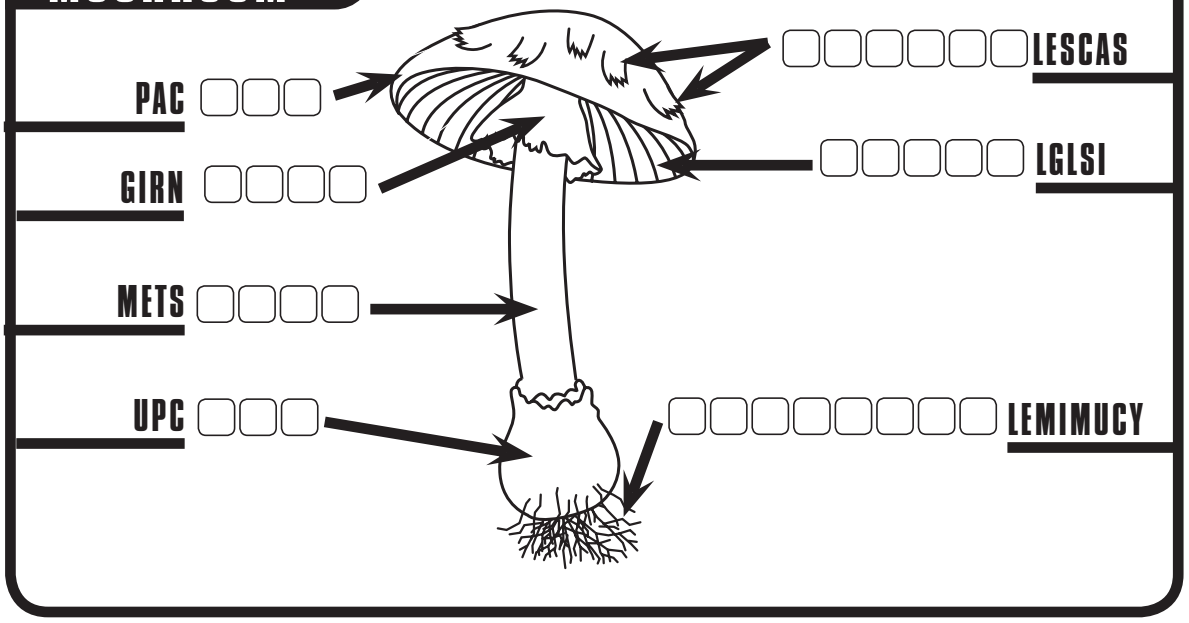
Anatomical Anagrams

1.3

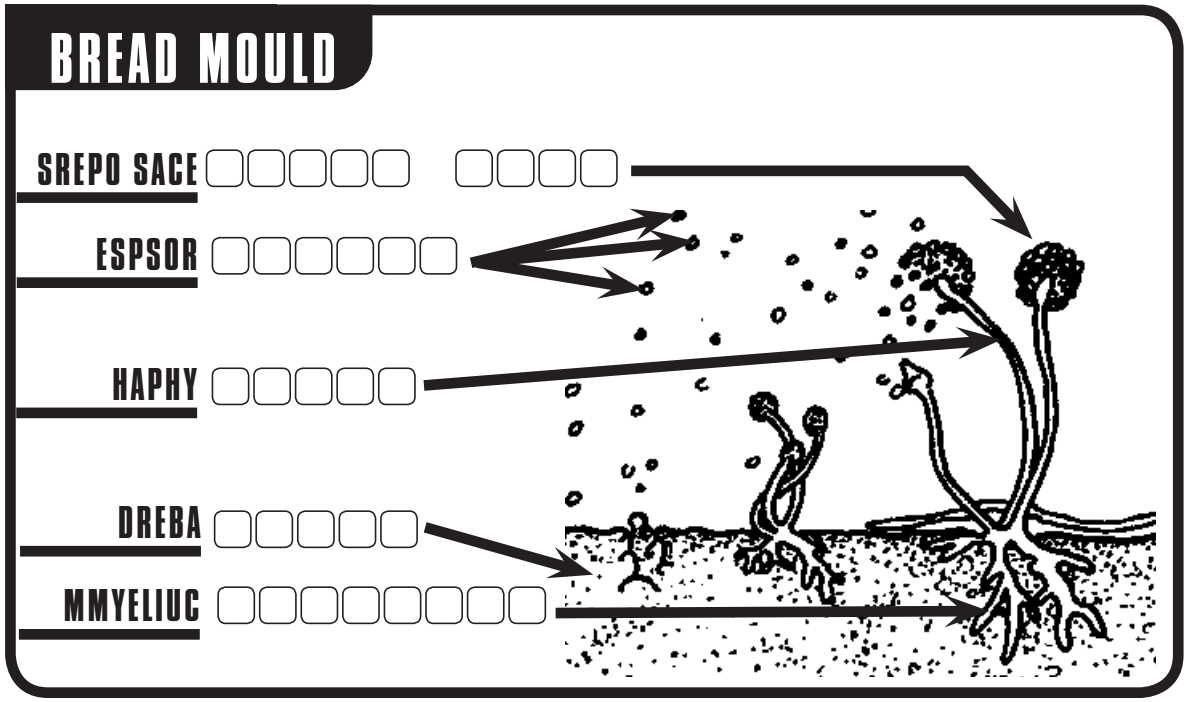
Directions

Unscramble the labels to complete the diagram of the main parts of a typical mushroom and bread mould.

MUSHROOM



BREAD MOULD



Key to the Fungal Treasures

Activity 1.4

GRADES
3-6

TYPE OF ACTIVITY
Identification Puzzle

MATERIALS
- copies of pages 27-29
- scissors
- glue or tape

VOCABULARY
cap
dichotomous key
pores
spines
stem

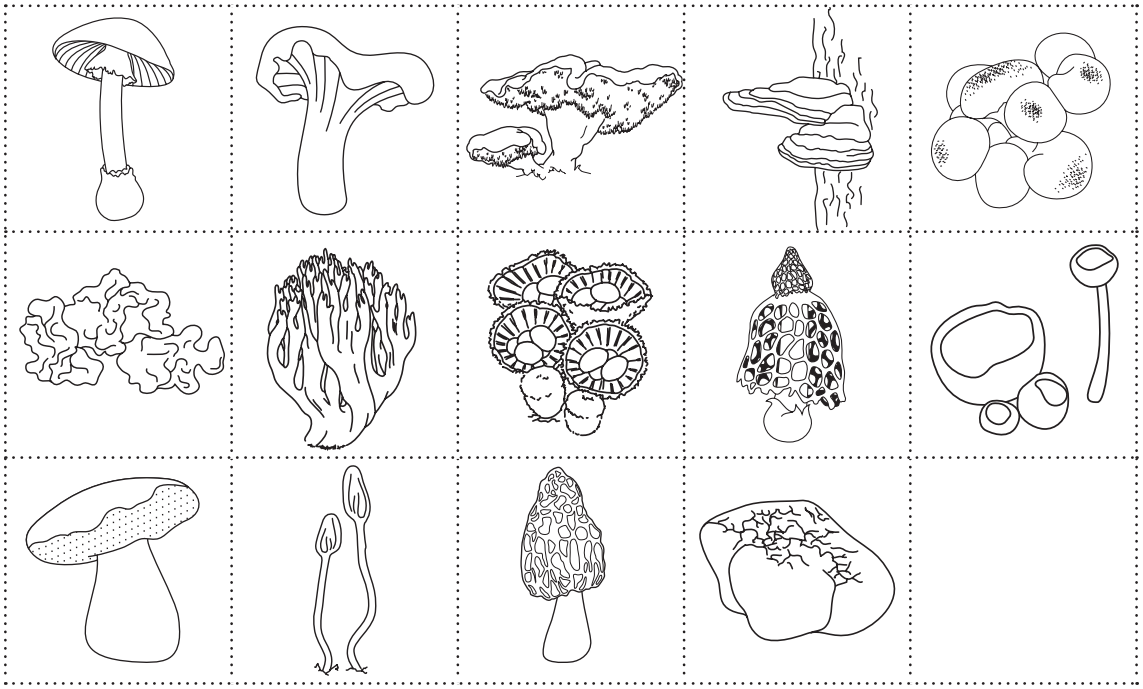
OBJECTIVE
- To familiarize students with the diversity of basic shapes of fungal fruiting bodies using "key-like" deductions.

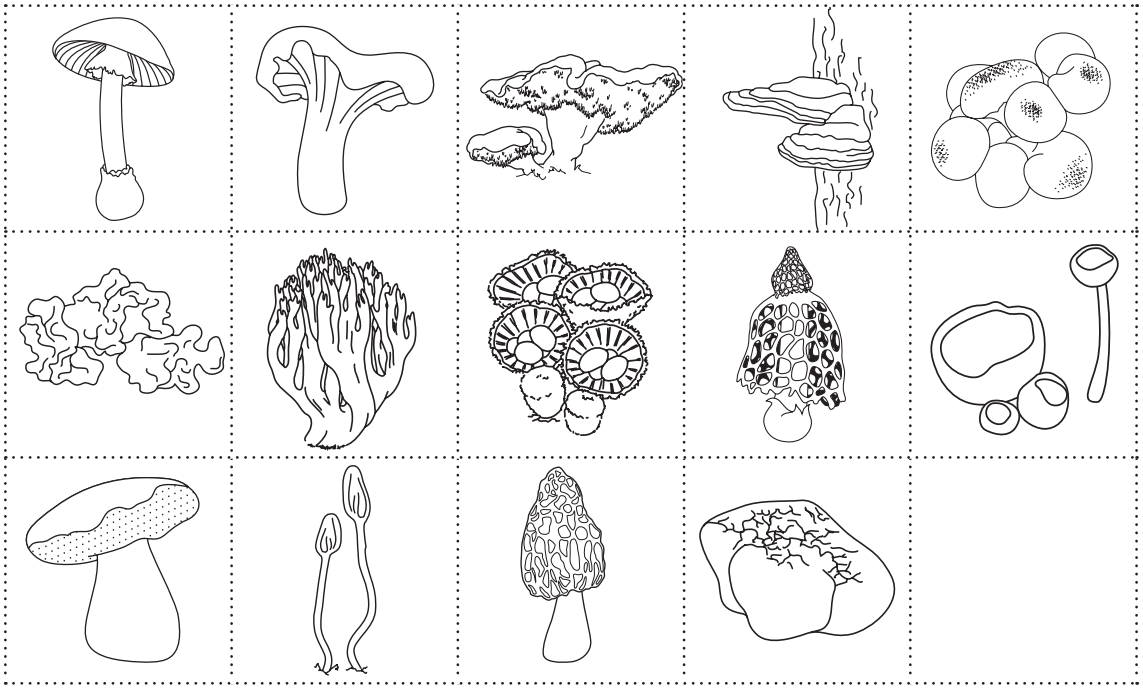
BACKGROUND INFORMATION
Scientists and naturalists use **dichotomous keys** to identify unknown organisms. A dichotomous key is structured on a series of choices between alternative characteristics. Although this activity does not reflect the perfect binary of a true dichotomous key, students are still introduced to the basic principles of keys for identification.

TEACHER INSTRUCTIONS
1. Copy a "Key to the Fungal Treasure" map and a set of mushroom stamps for each student.
2. Tell students they are going to identify 14 mushrooms.
3. Have them cut out the mushroom stamps and, by answering the questions, place them on the map.
4. When they are sure they have them in the right place (or you have checked over their map), have them tape or glue the mushrooms in place.
6. As a class discuss these mushrooms. Are students surprised to see the various shapes? Which of these groups are students already familiar with?

ANSWER KEY

Agaric **1**	Chanterelle **14**	Teeth Fungi **3**	Polypores **7**	Puffballs **8**
Jelly Fungi **6**	Coral Fungi **9**	Bird's Nest Fungi **4**	Basket Stinkhorn **13**	Cup Fungi **5**
Bolete **2**	Earth Tongues **11**	Morel **12**	Truffle **10**	





Key To The Fungal Treasure

Start here

Does it have a cap and stem?

Yes → Does it have gills under the cap?

Yes → 1 (Agaric)

No → Does it look spongy underneath the cap?

Yes → 2 (Bolete)

No → Does it have lots of jagged spines under the cap?

Yes → 3 (Tooth fungi)

No → Does it look like a shelf growing on a tree?

Yes → 7 (Polypores)

No → Is it cup shaped?

Yes → Does it look like a little nest with eggs"?

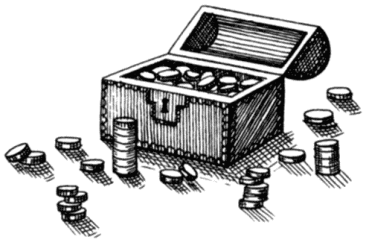
Yes → 4 (Bird's Nest Fungi)

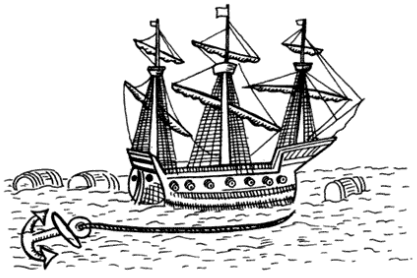
No → 5 (Cup fungi)

No → Does it look shapeless, rubbery, and like seaweed?

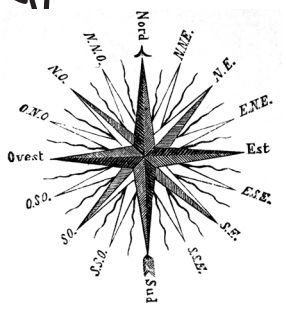
Yes → 6 (Jelly fungi)

No →





Oops. You've reached the end of the map. Go back to the start and try again! Good



Truffle

10

No

Does it look like a rock or an old potato?

Yes

No

Does it look like a matchstick with a flattened head?

Yes

11

Earth tongues

Coral fungi

9

No

Does it look wrinkly or a little bit like a brain?

Yes

12

Morel

Yes

Does it look coral from the ocean?

No

No

Does it look like the mushroom is wearing a lacy skirt?

Yes

13

Basket Stinkhorn

No

Does it looks like a clump of little balls?

Yes

No

Is it shaped like a vase with ridges on the underside?

Yes

Puffballs

8

Chanterelle

14

Fungal Fun! jokes, songs and quotes...

What did one mushroom say to the other mushroom?
Your one fungi to be with.

A mushroom went into a bar and saw some algae at a table. He went up to one and said "You're lookin' all gal (*algal*)." She looked him over and said "You look like a fun guy.(*fungi*)"
And they took a liken (*lichen*) to each other.

Why did the mushroom go to the party? Because he was a fun guy. Why did he leave the party? Because there wasn't mushroom!

I'm a fungi
yes I am
you'll find me
in your soda can!

Out in the yard
keepin' clean
I'll be working hard
at recycling.

When you are sick
I am here
offering mould
to aid the cure.

If you live to eat
you may find me
hiding under
your pizza cheese.

At recess, some kids were playing baseball when a strange looking fellow walked up to them and asked to join in the game. The kids looked and him and said "no way!" The stranger replied "but why not? I'm a fungi!"

Why did the mushrooms not let the last mushroom on the elevator?
Because he was a basket stinkhorn!

1. All fungi are edible
2. Some fungi are not edible more than once"
--Terry Pratchett