

## **It's Time For FUNgi**

Cassandra Davis, Ashley Kaya, Safaa Mouline, Shlok Rajurkar, Ryan Redmond | Spring 2023

**Field(s) of Interest:** Mycology, Ecology, Organismal Biology

### **Brief Overview:**

Mentees will be learning about fungi, their anatomy, physiology, and function in the ecosystem through hands-on activities and demonstrations.

### **Agenda:**

- Introduction (5 min)
- Module 0: Nice to Yeast You (10 min)
- Module 1: Reduce, Reuse, Decompose (10 min)
- Module 2: Spores Galore (10 min)
- Module 3: Let's Cap It Off (20 min)
- Conclusion (5 min)

### **Main Teaching Goals/Key Terms:**

- Fungus
- Food Chain
- Decomposer
- Compost
- Spore
- Stalk
- Cap
- Gills

## **Background for Mentors**

## Module 0

- Fungus
- Yeast

Fungi are considered to have their own kingdom in classification, separate from plants and animals. Fungi (**Fungus** singular) are eukaryotic and include yeast, mold, and mushrooms. It is cool to note that historically fungi were part of the plant kingdom but due to the lack of some key features like chlorophyll, they were reclassified.

Fungi can live in terrestrial or aquatic environments. In terrestrial environments, fungus can have symbiotic relationships with lichen and in aquatic environments, fungus can have symbiotic relationships with algae.

Fungi are important in many ways, one being their role in decomposing organic matter (more on that later!). Fungi is also prevalent in making prevalent foods! We use **yeast** for making bread, beer, and wine.



**Figure 1.** Yeast making bread rise!

## Background for Mentors

## Module 1

- Food Chain
- Decomposer
- Compost

A **food chain** is a hierarchical structure to describe the transfer of nutrients and energy from organism to organism within an ecosystem, divided into different trophic levels. Every ecosystem's food chain looks different in terms of the species, but the roles of the trophic levels remain consistent.

First, energy is produced by a producer (plant) through photosynthesis. Next, a primary producer (an herbivore) will eat this plant to gain energy. From there a secondary consumer will eat the herbivore (a carnivore)... and so on. When an organism dies, **decomposers** (fungi and bacteria) will break down the organic matter, returning the nutrients to the soil. These nutrients can then be used by producers for this cycle to repeat again.

### Decomposers' Role in the Food Web

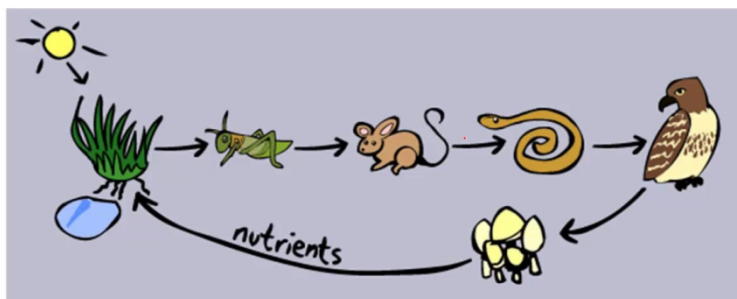


Figure 2. Flow of nutrients in a food chain.

When we **compost**, we are essentially allowing decomposers to do their job! We put organic material in soil and let microorganism decomposers such as bacteria and fungi to break down food waste into nutrients. These nutrients, such as nitrogen, phosphorus, and potassium are highly beneficial to the soil. This essentially acts as fertilizer, enriching the soil and the plants that will use the soil.

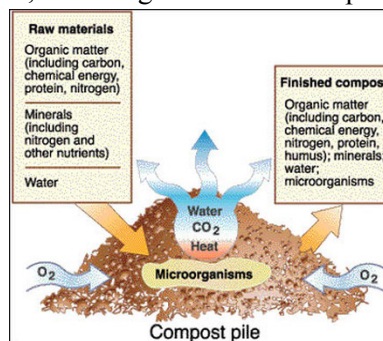


Figure 3. Compost pile. Note that we turn compost to supply oxygen to the microorganisms—they need it for aerobic respiration!

## Background for Mentors

## Module 2

- Spore
- Dispersal

A **spore** is a reproductive cell of fungi that is capable of developing into a new fungi. An easy way to think about a spore is as the “seed” of the fungi. Without spores, a fungi can not reproduce, and thus would die off.

Spore **dispersal** is the process of distributing fungal spores into the environment. Unlike animals, fungi can not walk long distances, which makes it more difficult to disperse their spores. Because of this, fungal spores are usually distributed in two types of ways: by nature and by animals.

Fungi that rely on the forces of nature to distribute their spores typically have to produce more spores due to the ineffectiveness of this method. Spores commonly travel by wind or by rain, but rarely end up further from their original fungi's location, and often die off due to landing in poor habitats for germination. When spores are dispersed by animals, however, the success rate is much higher. Animals can eat the spores and redistribute them by means of digestion or spores can travel in the fur of animals. This is a far more favorable method of dispersal because the spores are able to travel much further from the original fungi and are more likely to land in an environment with ideal germination conditions.

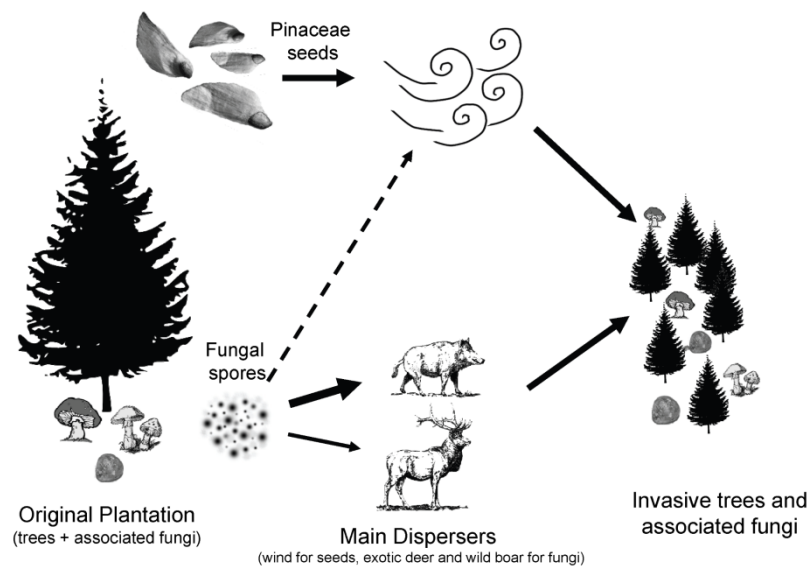


Figure 4. The two main methods of spore dispersal

## Background for Mentors

### Module 3

- Stalk
- Cap
- Gills
- Mycelium

A fungus generally has a few main anatomical elements that the build activity will focus on, most of which are only visible above the ground in the fruiting body. They are the **stalk**, the long trunk of a mushroom composed of hyphae; the **cap**, the often colored and unique top of a mushroom that covers the **gills**; the gills, which house and release the spores; and the **mycelium**, an underground network of fibers that sprouts and connects multiple fruiting bodies.

#### MUSHROOM ANATOMY

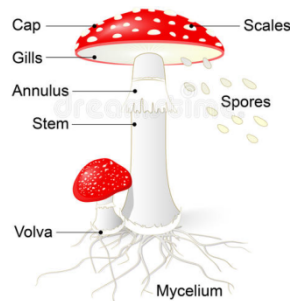


Figure 5. Fungal Anatomy

Besides these main components, fungi can come in a wide variety of colors, shapes, and sizes, composing a deeply diverse form of life. They can have scales, be composed of a lot of small fruiting bodies, and grow on a variety of substrates. The colors, smells, and toxins of a fungus can contribute to its place in the environment and whether it is avoided or consumed by animals. A small percentage of fungi are consumed by humans and include shiitake, porcini, truffles, chanterelles, and morels.



Figure 6. Fungal Diversity

## Introduction

This lesson introduces mentees to fungi as decomposers – which may be overlooked when learning about the food chain. Fungi play a very important role in our environment as well as in parts of our life that we can directly relate to (eg. yeast making bread rise).

<b>Concepts to Introduce</b> <ul style="list-style-type: none"><li>● Introduce fungi as a group of organisms that have a lot of different varieties but try to anchor the introduction to a specific type of fungus mentees are familiar with and can easily visualize, i.e., button mushrooms.</li><li>● Emphasize that mentees should only eat mushrooms that are sold in the grocery store or in a restaurant as those found outside may not be safe to eat.</li></ul>	<b>Questions to Pique Interest</b> <ul style="list-style-type: none"><li>● What is an example of a fungus? Where can you see fungi?<ul style="list-style-type: none"><li>○ Did you know that we can find fungi in our food?</li></ul></li><li>● Have you ever made compost?</li><li>● Have you ever seen a mushroom growing out of the grass?</li></ul>
<b>Scientists, Current and Past Events</b> <ul style="list-style-type: none"><li>● <a href="#">This article</a> talks about the common edible fungi - truffles - and their cultivation.</li><li>● Miles Joseph Berkeley (no known relation to UC Berkeley) <a href="#">discovered around 6,000 species of fungi</a>.</li></ul>	<b>Careers and Applications</b> <ul style="list-style-type: none"><li>● Mycologist: a type of scientist that studies and works with fungi</li><li>● Ecologist: a type of scientist that studies the relationships between organisms and their environments</li><li>● Food science: a field involving the study of food safety and production</li><li>● Chef: a professional cook who prepares food</li></ul>

## Module 0: Nice to Yeast You

This module is a simple demo of a real-life fungi: yeast! Mentors will do an experiment that involves a reaction between yeast and sugar to make a balloon inflate. This will introduce mentees to the topic of fungi and give a real-world application of a common fungus.

<b>Teaching Goals</b> <ul style="list-style-type: none"><li>● <b>Yeast:</b> a type of fungus commonly used to make bread</li><li>● <b>Fungus:</b> organisms including yeasts, molds, and mushrooms</li></ul>	<b>Materials</b> <ul style="list-style-type: none"><li>● Yeast packet</li><li>● Sugar</li><li>● 3 empty plastic water bottles</li><li>● 3 balloons</li><li>● Warm water in a thermos</li></ul>
--	--

### Procedure

1. Pour some water from the thermos into each of the empty water bottles.
2. Add some yeast to each, in increasing amounts (eg. 1 tablespoon, 3 tablespoons, 5 tablespoons)
3. Add 2 tablespoons of sugar to each mixture.
4. Stretch a balloon over the top of each water bottle.
5. Ask mentees what they think will happen and whether different amounts of yeast will affect the outcome.
6. Watch the balloons start to expand and come back to it later on in the lesson (about 15 mins later).
7. Ask the mentees why they think certain balloons expanded more than others– what did we do differently for each (varying amounts of yeast)? Yeast is a fungus! Use this to transition into the rest of the lesson, focusing on fungus.



**Figure 1:** Yeast demo set up as varying levels of yeast. More yeast creates greater inflation!

### Classroom Notes

The reaction will take some time to progress and cause inflation, so try to mix the yeast early in the interest of time and keep the students engaged with the demo while it reacts.

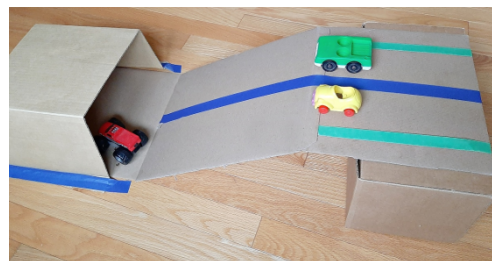
## Module 1: Reduce, Reuse, Decompose

This module activity will demonstrate how fungi play a role in the food chain of an ecosystem. Mentors will play a part in the ecosystem and mentees will be able to see how nutrients travel through the environment.

<b>Teaching Goals</b> <ul style="list-style-type: none"><li>● <b>Food Chain:</b> a series of organisms, each dependent on the next as a source of food</li><li>● <b>Decomposer:</b> an organism that breaks down dead or decaying organisms and returns their components to the environment</li><li>● <b>Compost:</b> decayed organic material used as fertilizer, often kitchen or yard waste</li></ul>	<b>Materials</b> <ul style="list-style-type: none"><li>● Cardboard ramp (make before site)</li><li>● 5 ping pong balls</li></ul>
--	--

### Procedure

1. Ask mentees if they have heard of compost. What is compost? How is it made? Then, introduce decomposers.
2. Mentors will construct a cardboard ramp BEFORE the lesson.
3. Have mentors introduce which role they will play in the ecosystem (eg. herbivore, carnivore, decomposer).
4. Make it clear that the ping pong balls represent nutrients in the ecosystem.
5. In the order of the food chain (eg. producer - herbivore - carnivore - decomposer), have one mentor take a ping pong ball and roll it down the ramp.
  - a. This represents the use of nutrients by an organism.
6. For consumer organisms such as herbivores and carnivores, have the mentor playing the role pretend to die.
7. The mentor playing the decomposer can now come in and take the ball at the bottom of the ramp and place it back at the top of the ramp.
8. Repeat the cycle of using nutrients (rolling the ball down the ramp), organisms dying (making the nutrients available), and decomposers recycling the



**Figure 1:** Cardboard ramp to roll our “nutrient” ping pong balls down.



nutrients back into the environment (placing the ball back at the top of the ramp).

**Classroom Notes**

If the mentees are not familiar with members of an ecosystem, mentors can use the terms “plant eater” and “meat eater”, since the focus is more so on the decomposers. For younger mentees, mentors should be careful about how to portray/explain organisms dying.

## Module 2: Spores Galore

Mentees will learn about how fungi disperse their spores in order to grow more types of fungi in the environment.

<b>Teaching Goals</b> <ul style="list-style-type: none"><li>• <b>Spore:</b> can think of this as the seed of a fungus, often adapted to very harsh conditions</li><li>• <b>Dispersal:</b> the process by which fungi spread their spores to new sites for growth</li></ul>	<b>Materials</b> <ul style="list-style-type: none"><li>• Various colors of construction paper</li><li>• Markers</li></ul>
--	---

### Procedure

8. Distribute two pieces of construction paper to each mentee
  - a. Try to give each mentee a different color!
9. Have the mentees write their names on their own papers.
10. Instruct the mentees to crumple the pieces of paper into a ball.
11. Have the mentees stand up (but not move away from their table) and throw their balls of paper anywhere they want in the classroom.
12. After everyone has thrown their paper balls, let mentees move around the classroom to locate their balls.
13. Without moving the paper ball, have mentees unfold the paper onto the ground.
  - a. The area of unfolded paper represents where the mentee (fungus) released their spores (paper balls) and this is where a new patch of fungi will grow.

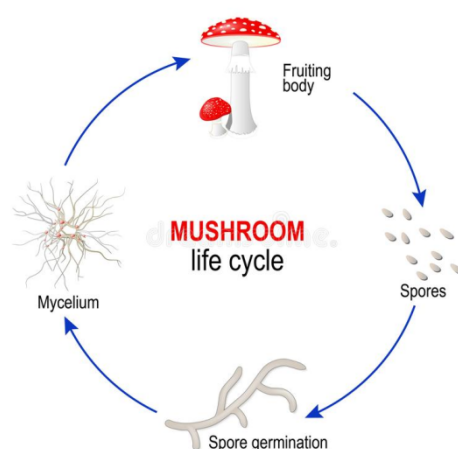


Figure 1: Fungi life cycle

### Classroom Notes

Make sure mentees are not throwing their paper balls at each other! For more rambunctious mentees, make sure to enforce classroom management so they don't start to run around or move their paper balls.

## Module 3: Let's Cap it Off

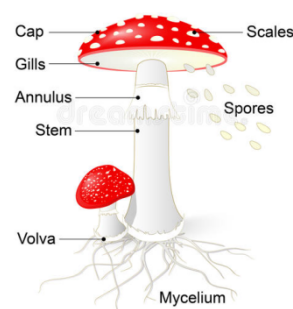
Mentees will learn about fungi anatomy and build their own fungus with Playdough, pipe cleaners, and other craft supplies.

<p><b>Teaching Goals</b></p> <ul style="list-style-type: none"> <li>● <b>Stalk/Stem:</b> the “trunk” of a mushroom (also called the stipe). Not all mushrooms have stipes.</li> <li>● <b>Cap:</b> the top part of a mushroom that covers the gills</li> <li>● <b>Gills:</b> contain and disperse the spores</li> <li>● <b>Mycelium:</b> underground network of fungal “roots” that can produce fruiting bodies (mushrooms) above the ground</li> </ul>	<p><b>Materials</b></p> <ul style="list-style-type: none"> <li>● 10 containers of playdough (various colors)</li> <li>● 50 pipe cleaners (various colors)</li> <li>● Tissue paper</li> <li>● Beads</li> </ul>
--	---

## Procedure

1. Split mentees into groups as desired.
2. Give each group/table of mentees:
  - a. A diagram showing the basic anatomy of a fungus OR draw the basic anatomy on a whiteboard
  - b. A handout with images of various fungi of different shapes, colors, and sizes
  - c. 3-4 containers of playdough
  - d. 15-20 pipe cleaners
  - e. Several pieces of tissue paper
  - f. A handful of beads
3. Instruct mentees to build a fungus with the provided materials, including the various parts on the diagram and whatever other embellishments they wish to add.
  - a. Encourage mentees to be creative! There are millions of species of fungi and no one way a fungus should look.
4. Ask mentees to come up with ways the fungus can avoid predation, i.e., poisonous cap, bright colors, a certain smell.

### MUSHROOM ANATOMY



**Figure 1:** Diagram of a fungi.



**Figure 2:** The diversity of fungi.

## Classroom Notes

Encourage mentees to share the colors of Playdough and pipe cleaners across tables. Depending on the arrangement of the classroom, it may be difficult for mentees to reference the anatomy of a mushroom if

the drawing is on the board. In this case, use the handout.

## Conclusion

To conclude, mentors should emphasize the importance of fungi in our ecosystems and how we can find fungi in our everyday lives - even things that don't seem like fungi! It is also helpful to introduce ways we can learn more about fungi and the variety of jobs, from studying fungi like a mycologist or working with food like a chef, that have to do with fungi.

## References

- <https://www.exploratorium.edu/cooking/bread/activity-yeast.html#:~:text=As%20the%20yeast%20feeds%20on,balloonlike%20bubbles%20in%20the%20dough.>
- <https://www.britannica.com/science/fungus>

## Summary Materials Table

Material	Amount per Site	Expected \$\$	Vendor (or online link)
Yeast	1 scoop	0	Bechtel
Sugar	1 scoop	0	Bechtel
Empty plastic water bottles	3	0	Already own
Playdoh	10	0	Bechtel
Balloons	3	0	Bechtel
Cardboard pieces	3	0	Bechtel
Ping pong balls	5	0	Bechtel
Construction paper	15	0	Bechtel
Markers	5	0	Bechtel
Pipe cleaners	50	0	Bechtel
Tissue paper	15	0	Bechtel
Beads	45	0	Bechtel