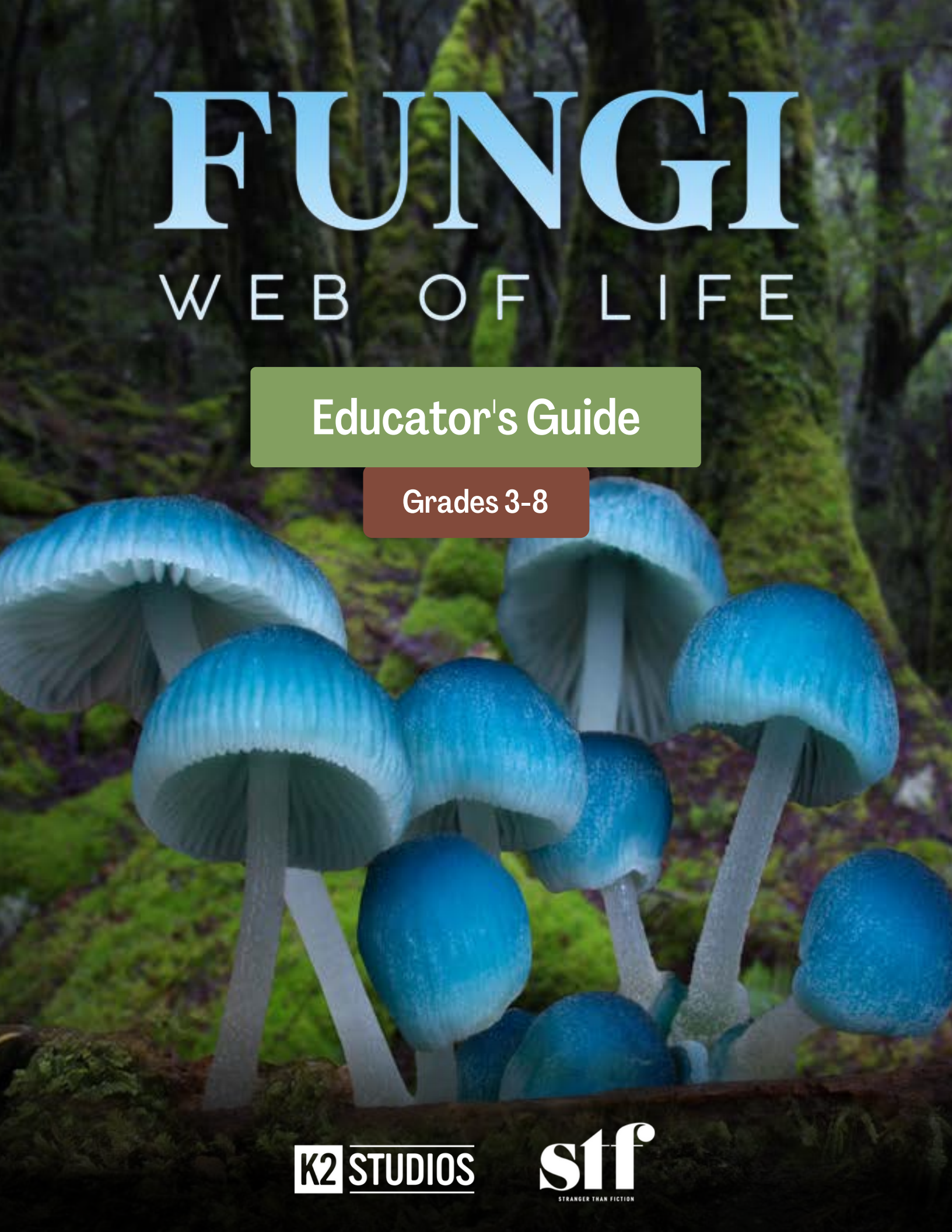
FUNGI
WEB OF LIFE
Educator's Guide
Grades 3-8
K2 STUDIOS
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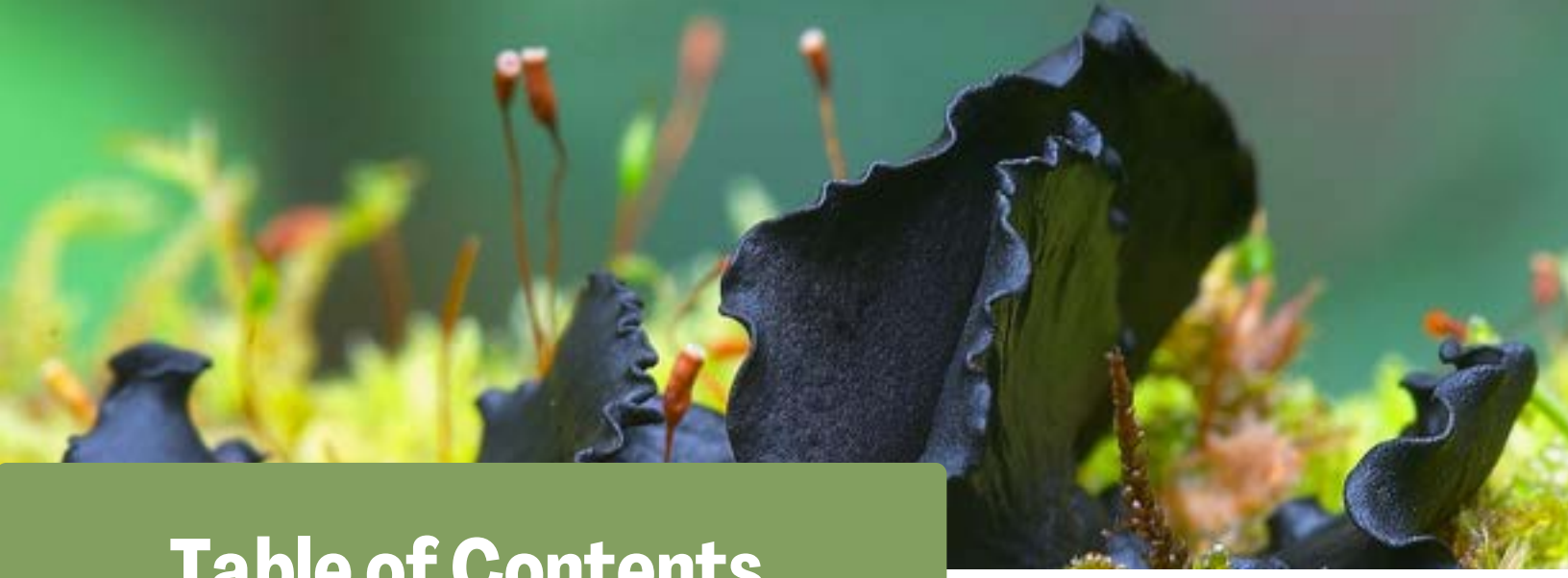


Table of Contents

Welcome

Fungi: Web of Life Educator's Guide

This curriculum-linked guide for Grades 3-8 offers experiential learning opportunities for students before and after watching ***Fungi: Web of Life***. Students will explore the remarkable behavior of fungi through outdoor activities, scientific experiments, large group simulations, and creative activities in art or drama. Each lesson connects to the Next Generation Science Standards (NGSS), covering characteristics of organisms, life cycles, and habitats for students in Grades 3-5. Learners in Grades 6-8 will examine ecosystem roles, the interconnection of organisms, and environmental protection. By studying the hidden life of fungi, students will see how the living world is connected by a vast kingdom of life that has much to teach us about cooperation and adaptation in a time of radical change.

Taking Students Outside

Create a code of conduct with students on safety and care for the natural world.

Ensure students work in pairs or small groups.

Set clear boundaries on where students can go.

Create a call or a signal to indicate when it is time to rejoin the group.

Keep extra clothing in the classroom to help students dress for the weather.

Glossary

Cap. Also called a *pileus*, a cap sits at the top of a mushroom where it protects the spores. Note that not all mushrooms have a cap!

Decompose. To break down living beings. Many fungi are known as *decomposers,* who dissolve organic matter and absorb the broken down bits as food.

Habitat. A place where a living being can get everything they need to survive.

Hypha. A thread-like part of a fungus that grows outward from the tip. A hypha can sense what's around them and tells other hyphae where to grow next. Plural = *Hyphae*.

Lignin. For wood to be rigid, the cell walls need a substance called lignin. Lignin is very hard to break down, but fungi are up for the task.

Mushroom. Weave hyphae into a tight bundle, then inflate with water and you've got yourself a mushroom! Mushrooms are the sporing body of a fungus. Only a small number of fungi produce mushrooms.

Mycelium. A network of connected hyphae produced by an individual fungus that absorbs and transports nutrients. Plural = M*ycelia*.

Mycologist. A human-being who studies fungi.

Mycorrhizal Fungus. A type of fungus that attaches to the roots of plants and forms a symbiotic relationship.

Spores. Tiny particles that exit the fungus as part of the reproductive cycle. Out of spores, a young fungus will grow.

Stalk. Also called a *stipe*, this cylindrical part of a mushroom holds up the cap.

Symbiosis. Relationships between different organisms where all involved can benefit or one organism benefits at the expense of others. Adjective = S*ymbiotic*.

Wood Wide Web. A term used to describe the connectivity between fungi and trees.

Lesson 1 | Grade 3-5

Meet a Fungus

This lesson is recommended before or after watching ***Fungi: Web of Life***.

NGSS Disciplinary Core Ideas

LS1.A Structure and Function

LS3.A Inheritance of Traits

LS3.B Variation of Traits

Lesson Length

2 hours, 25 minutes

Lesson Summary

Students will learn the anatomy of fungi and examine the diversity of fungi both globally and in their neighborhood.

1. Thinking Cap

10 minutes

Materials

- Construction or scrap paper x 4
- Marker
- Tape

Instructions

Using the paper, create four signs: one reads 'PLANTS,' one reads 'ANIMALS,' one reads 'FUNGI,' and one reads 'ALL.' Tape each sign in a different part of the room where students can move to.

Gather students in the middle of the room. Explain that there are different types of organisms on Earth, such as plants, animals (including humans), and fungi. Each group has characteristics that are unique to them as well as characteristics that are shared.

State various characteristics of organisms (see page 4), one-by-one. Students will decide which organism the characteristic belongs to by moving to the corresponding sign. Once all students have moved, reveal the correct answer. Continue until all statements are read.

Ask students if they were surprised by any of the characteristics of fungi. Reiterate that fungi are neither plants nor animals. While they have characteristics of both, they are in a group of their own.

The Fungi Queendom is seemingly the most expansive on earth yet only about 5-10 % of fungal diversity is known. - Fungi Foundation [1]

Lesson 1 | Grade 3-5

Meet a Fungus

Characteristics of Earth's Organisms

- I am a living being - ALL
- I make **mushrooms** - FUNGI
- I grow and change throughout my life - ALL
- I have muscles that help me move - ANIMALS
- I am known as a **decomposer** - FUNGI
- Humans can eat me, but some of my family members are toxic - ALL
- I can (safely) eat plastic - FUNGI
- I usually use photosynthesis to make food - PLANTS

2. Fungus Anatomy

1 hour

Materials

- Store/market-bought edible mushrooms, any kind x 1 per pair
- Drawing utensils
- Construction or scrap paper x 2 per student
- Child-appropriate slicing tool (i.e., wooden cutter) x 1 per pair

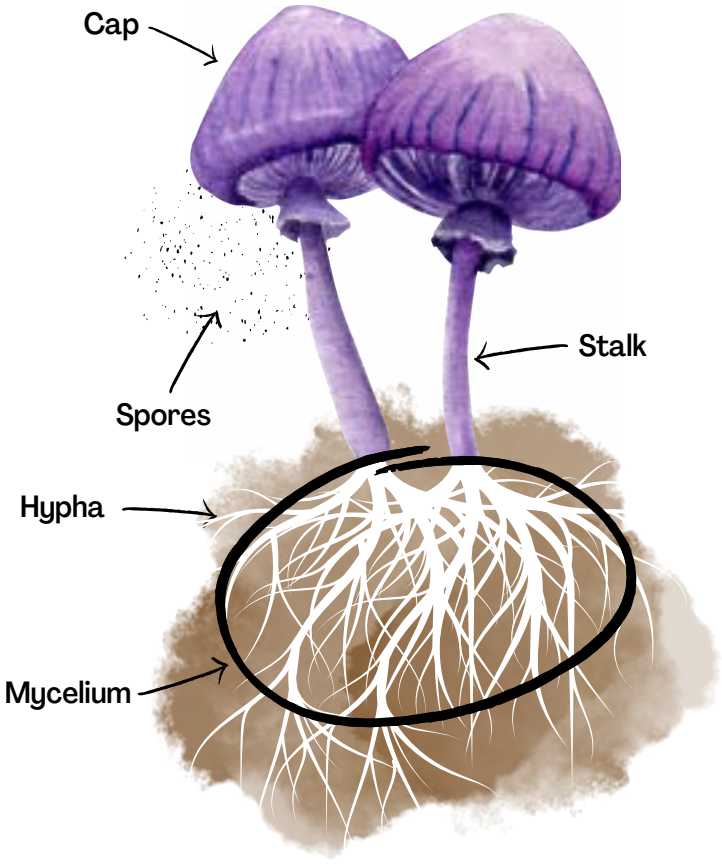
Instructions

Gather students in pairs and hand out a mushroom, scrap paper, and slicing tool to each group. Start by examining the whole mushroom together as a class. Invite students to use multiple senses as they meet this fungus. What do they notice about the size, shape, texture, smell, sound, and color of the mushroom?

Invite students to gently cut open the mushroom. What do they notice inside?

Show students a diagram with basic parts of fungi labeled: **cap**, **stalk**, **hypha**, **mycelium**, and **spores**. Invite students to guess the function of each part. Record guesses on a board or equivalent. Then reveal what each part is for (see '*Glossary*').

Students will then take a piece of paper and fold it in half. On one side, they will trace the cut mushroom, label all parts, and add color or texture as they wish.



Lesson 1 | Grade 3-5

Meet a Fungus

Elsie Wakefield (1886-1972) was a **mycologist** who studied the anatomy, habits, and appearance of fungi. She wrote and illustrated several field guides and worked as the Head of Mycology at Kew Gardens in the early 1900s.[2]

On the other half of the paper, students will write the following, filling in the blanks with a word or statement that feels true for them.

- Like a stalk, I have _____ to hold me up.
- Like a cap, I have _____ protecting my organs.
- Like hyphae, I have _____ to sense the world.
- Like a mycelium, I connect with my family by _____.
- Like a spore, I start new things by _____.

3. Diversity of Fungi

1 hour

Materials

- Images of Fungi (Appendix A)
- Gills, Pores, and Teeth Images (Appendix B)
- Tape or sticky tack • Writing utensils
- Comparing Fungi Worksheet (Appendix C) x 1 per student

Instructions

Like humans, fungi are diverse in their appearance! The appearance of each species depends on the 'parent' fungus or the fungi that came together in order for spores to form. For some fungi, spores are released from the cap through gills, pores, or teeth, which vary between species (show Appendices A & B).

Cut out and tape images of fungi from Appendix A, 'Set 1' on a board or equivalent, excluding the species name. Hand out one image to each student from 'Set 2'. If there are more than eighteen students in the class, print duplicate images from each set.

Share that the fungi on the board have released spores. Those spores have grown into hyphae and have now formed a sporing body (images in 'Set 2'). Students must examine the characteristics of their fungus and tape their image next to the 'parent' fungus. Choose a few examples and ask students how they identified the 'parent'. Which traits did their fungus inherit? Are there any differences between the 'parent' fungus and the offspring?

Take image 'Set 2' off the board, shuffle the images and hand back out to students. Repeat the activity so students have a second opportunity to match the fungi.

Good 'Morels'

Just like fungi, we can plant seeds - or spores - too; seeds of love, kindness, and compassion that we can plant in the hearts of everyone we meet. We can water those seeds with our kind actions and watch the happiness around us grow. Which seeds - or spores - will you plant and water today?

Next, take students outside and look for mushrooms. For each mushroom found, students will fill out the 'Comparing Fungi Worksheet'. If students do not find any mushrooms, ask why they think there are no mushrooms here. Reveal that not all fungi produce mushrooms. Those that *do* must have the right conditions for mushrooms to form. Ask students what fungi might need to form mushrooms? Share that students will explore the **habitat** needs of fungi in Lesson 3.

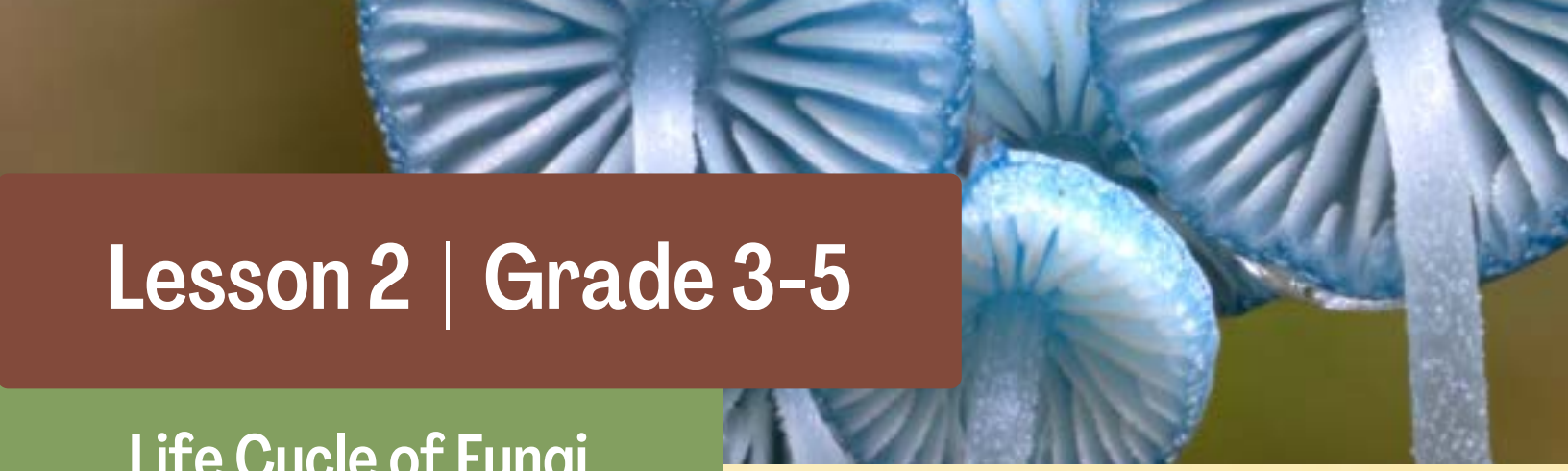
4. Closing

15 minutes

Instructions

Ask students to recall the ways in which they are like fungi. Ask what makes fungi unique in comparison to plants and animals. Remind students that each species of fungus has characteristics that are the same among individuals of a particular species, but also characteristics that differ between individuals. There are many ways to be a fungus! Similarly, there is some sameness among humans, but also individual differences. Invite students to share one thing that makes them the same as their classmates and one thing that makes them unique.

Recall that the characteristics of a fungus are passed down from their parents. Ask students how they are like their parents, guardians, or the people they are with the most. Do they have any talents, skills, or knowledge that has been passed down to them? What knowledge about fungi do they hope to pass on to the people in their life?



Lesson 2 | Grade 3-5

Life Cycle of Fungi

This lesson is recommended after watching ***Fungi: Web of Life***.

NGSS Disciplinary Core Ideas

LS1.A Structure and Function

LS1.B Growth and Development of Organisms

LS2.A Interdependent Relationships in Ecosystems

LS2.B Cycles of Matter and Energy Transfer in Ecosystems

LS4.B Natural Selection

Lesson Length

2 hours, 30 minutes

Lesson Summary

Students will learn the life cycle of fungi through a dynamic simulation and conduct an experiment to explore spore dispersal strategies of various fungi.

1. Thinking Cap

30 minutes

Materials

- Photos from home (see '*Instructions*')
- Construction paper x 1 per student
- Drawing utensils
- Tape

Instructions

Ask students to bring in three photos from home: one photo of themselves as a newborn, one as a toddler, and one at school age.

Note: If students do not have these photos, they may draw themselves instead for this activity.

Ask students to list the big life stages of a human. Responses may include birth, toddler, child, teenager, adult, older adult, and death.

Share that all living beings have life cycles of birth, growth, and death. Throughout the cycle, they might *rely* on others to survive and they might *help* others survive.

For example, some fungi *take* nutrients from plants and animals to eat. Fungi can also *give* nutrients to plants and animals, even after death by releasing nutrients as the fungi decompose.

Given the intrinsic interconnectedness between fungi and other organisms, conserving fungi is vital to their existence and that of all biodiversity. - Alison Pouliot and Tom May [3]

Lesson 2 | Grade 3-5

Life Cycle of Fungi

Hand out paper and drawing utensils. Each student will tape their photos on the paper from the oldest photo to the most recent or draw themselves at the life stages they have already gone through.

Students will then think of what they want to 'give' to others in their future life stages. How can they help people or other living beings just like fungi? Students will draw themselves helping others as teenagers and beyond. Allow time for students to share about the ways they want to 'give' as they go through their life cycle.

2. Growth of Fungi

30 minutes

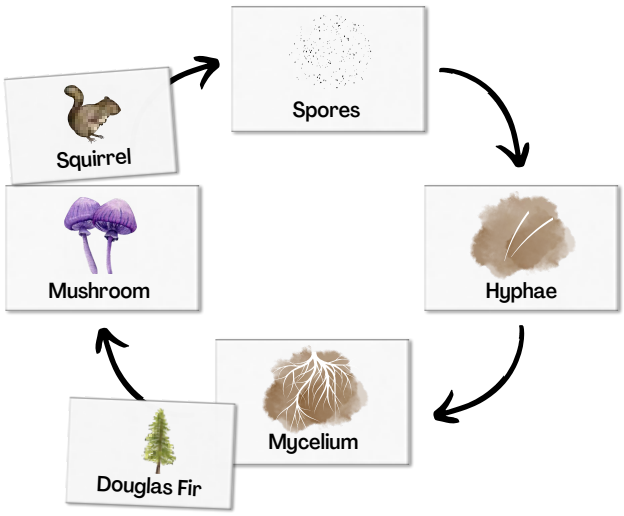
Materials

- Popsicle sticks or equivalent x 7 per student in one color to represent water and x 3 per student in another color to represent food
- Growth of Fungi Game Cards x 1 set - Card 1 & Card 2 - per student (Appendix D)
- Fungus Life Cycle Cards x 6 sets (Appendix E)

Instructions

Gather students in a large space, indoor or outdoor and distribute all the popsicle sticks on the ground, spread out at random. Hand out a laminated spore/hyphae Growth of Fungi Game Card (Card #1) to each student. Set the mycelium/mushroom cards (Card #2) aside.

Reveal that students have turned into fungi and have started their life as a spore! They will follow the instructions on their spore/ hyphae card, gathering water and food. Prepare to hand out the mycelium/ mushroom card to students once their hyphae needs are met. When all students have completed their life cycle, reset the game and play at least one more round.

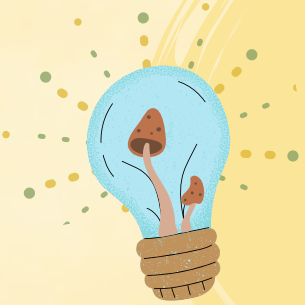


Divide students into six groups and hand out a Fungus Life Cycle Card set to each group. Starting with spores, students will assemble the life cycle of a fungus.

With the remaining plant and animal cards, students will guess their interactions with the fungus, recalling what was shared in ***Fungi: Web of Life*** (i.e., animals eat mushrooms and spread spores). Plant and animal cards will be placed next to the life stage where they think the interaction takes place. Flip over the cards to reveal interactions.

Lesson 2 | Grade 3-5

Life Cycle of Fungi



A single species of fungus can have hundreds of 'mating types'. When mycelia with *different* mating types come together from the same species, mushrooms have a chance to form! Mycelia with the *same* mating type are too close genetically to mate.

3. Spreading Spores

1 hour, 15 minutes

Materials

- Spreading Spores Worksheet (Appendix F)
- Lightweight tiny seeds (i.e., basil, chives, oregano) x 1 pinch per pair
- Heavy seeds (i.e., pea, cucumber, watermelon, beans) x 5 seeds per pair
- Tape • Measuring tape x 3, shared
- Wide bowl or tray x 1 per pair
- Empty pill bottle or equivalent x 1 per pair
- Spoon • Water
- Water bottle or equivalent x 1 per pair
- Dried leaves/grass or equivalent
- Drawing utensils • Sponge x 1 per group
- Mint extract, shared • Rocks x 4 per group
- Sticky notes x 1 per pair
- Blank paper x 1 per student
- Gills, Pores, and Teeth Images (Appendix B)

Instructions

Share with students that spores are often compared to the seeds of a plant. They both carry the genetic information of their 'parent' and are dispersed in similar ways. Ask students to recall how spores are dispersed as shown in ***Fungi: Web of Life*** or if they know any seed dispersal strategies. Answers may include dispersal by wind, water, or by animals.

Students will now test three spore dispersal strategies and decide which they think is best for spreading spores. Start by gathering students into pairs and handing out the items listed under '*Materials*' from the Spreading Spores Worksheet to the paper.

Following the worksheet instructions, students will conduct experiments using seeds in place of spores.

Hand out sticky notes to each pair and write 'WIND,' 'WATER,' and 'ANIMALS' on a board or equivalent. Based on their experiments, groups will decide which strategy they think is best for spreading the most spores and write their response on the sticky note, along with one sentence explaining their choice.

Good 'Morels'

Instead of picking mushrooms for a personal collection, consider drawing the mushroom in a nature journal or taking a photo instead. By leaving the mushroom as you find it, the fungus will have a chance to spread their spores and continue their life cycle using their natural spore dispersal strategies.

Groups will place their sticky note on the board, under the strategy they picked. As a class, identify which dispersal strategy was thought to be the best for spreading spores and read out loud some of the reasons why.

Students will then design and illustrate a mushroom with what they believe is the best spore dispersal strategy and show spore dispersal in action. Show students images of gills, pores, and teeth on mushrooms as examples of spore-producing areas on a mushroom that they may wish to include in their illustration. To finish, students will name their fungus and hang their illustration in a classroom gallery.

4. Closing

15 minutes

Instructions

Ask students to recall which living beings or elements of the Earth a fungus needs to spread spores. Possible responses include wind, rain, or animals like the Long-nosed Potoroo. What do fungi need from living beings or elements of the Earth in other parts of their life cycle - as a hypha, a mycelium, or as a spore?

Ask students to consider how these same/similar living beings or elements of the Earth help each of them grow and develop as humans. Knowing that humans are living beings like fungi and have similar needs, what choice could students make today that would help protect the living beings and elements of the Earth that are supporting their lives and the lives of fungi?

Lesson 3 | Grade 3-5

A Mushroom's Favorite Place

This lesson is recommended after watching ***Fungi: Web of Life***.

NGSS Disciplinary Core Ideas

LS1.D Information Processing

LS2.C Ecosystem Dynamics, Functioning, and Resilience

LS2.D Social Interactions and Group Behaviour

LS4.C Adaptation

Lesson Length

3 hours, 35 minutes

Lesson Summary

Students will examine habitats of fungi by graphing climate data and experimenting with mushroom growth under different conditions. Communication of fungi to meet habitat needs will also be explored.

1. Thinking Cap

20 minutes

Materials

- Neighborhood photos (see '*Instructions*')
- Tape
- Sticky Notes

Instructions

Ask students to bring in various photos of their neighborhood, either gathered from an online search or by taking photos.

Clear a space on the classroom wall and invite students to tape their photos to the wall. Share with students that all of these parts of the neighborhood make up their **habitat**.

Ask students what their basic needs are. Responses may include food, water, shelter, and space. Ask students to look at the photos and identify where they get food, water, shelter, and space in the neighborhood. Hand out sticky notes and add additional places to the wall where students have their needs met.

Share with students that although we all have the same basic needs, we also have individual preferences.

Puhpowee, [Anishinaabe ethnobotanist Keewaydinoquay] explained, translates as "the force which causes mushrooms to push up from the earth overnight." - Robin Wall Kimmerer [4]

Lesson 3 | Grade 3-5

A Mushroom's Favorite Place

Share the following 'preference' statements and have students raise their hand if the statement feels true for them. Students will switch spots with someone else who has raised a hand.

Preference Statements

I prefer hot over cold // I prefer solitude over groups // I prefer light over dark // I prefer dry weather over rain

Share with students that we often try to find a place to live that meets our basic needs as well as our individual preferences. Fungi also have basic needs and species-specific preferences that determine where they are found in the world. Ask students to predict whether fungi prefer hot/cold, light/dark, dry/rain, and solitude/groups. Record answers to revisit later.

Materials

- takayna / Tarkine Climate and Tree Data (Appendix G)
- Local temperature, rain, and tree cover data
- Edible mushroom growing kit x 4*
- Graph paper x 3 per student
- Pencil crayons, various colors
- Blank paper x 1 per student

**Note*: Mushroom growing kits are generally available to purchase online.

Instructions

Recall from ***Fungi: Web of Life*** that the takayna / Tarkine is an ancient rainforest on the Island of lutruwita / Tasmania, home to a vast diversity of fungi. But, why? What makes the takayna / Tarkine a good habitat for fungi?

Show students the takayna / Tarkine Climate Chart, depicting the average precipitation and temperature over several years, as well as current tree cover. Using the graph paper, students will redraw the precipitation and temperature data and note the tree cover.

Next, show graphs of average precipitation, temperature, and tree cover in the students' region. Using a different color, students will overlay this data on their takayna / Tarkine graph.

Calculate the annual precipitation and temperature averages for each place and compare the findings. Which place has more precipitation, warmer temperatures, and more tree cover annually? Based on the findings, ask students what kind of habitat fungi prefer. Why might there be more or less fungi in the students' region?

Lesson 3 | Grade 3-5

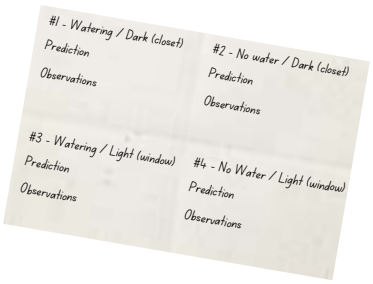
A Mushroom's Favorite Place

The Indigenous Peoples of lutruwita / Tasmania named the Tarkine 'takayna' (tah kye nah) in the language of palawa kani. 'takayna' or 'tarkiner' is the name of the Indigenous Peoples from the takayna region.[5]

Bring out the mushrooms kits** and distribute blank paper to students. Students will fold the paper into four sections.

As a class, decide on the growth conditions to test. Options may include water versus no water, warm versus cool growing location, or light versus dark growing location.

Label each kit with the parameter chosen. Students will write or draw their predictions for each kit on their blank paper.



Students will note their daily observations over several weeks. Once mushrooms have sprouted, students will indicate which growing conditions they think fungi prefer and which they could not survive in, by writing or drawing their response on the back of their observation sheet. Revisit predictions about the preferences of fungi from the '*Thinking Cap*' activity and compare with the results.

***Note*: If you are unable to acquire kits, take students outside and look for wild mushrooms. Try conducting the experiment for wild fungi, using the same watering parameters and gently creating shade or space for light to get in.

3. Talking Fungi

30 minutes

Materials

- Fungus Communication Cards (Appendix H) x 1 set per group

Instructions

Fungi are able to find what they need in their habitat by communicating through the mycelium. Some communicate with electrical signals, some communicate with scents or chemicals, and others communicate in ways that are still unknown. When they find food or water, they send out a signal telling all the hyphae where to grow next.

Distribute several sets of Fungus Communication Cards in a large play area outside. Gather students in groups of four or five (ensuring there is one card set per group). Tell students that individually they are hyphae, but they've come together as a group and are now a mycelium. Groups will start by coming up with a silent way to communicate. How will they say yes and no, and how will they get each other's attention from far away without speaking?

Good 'Morels'

The trees of the takayna / Tarkine are currently being cut down to sell the wood. Make a commitment to change one habit or item in your life that uses wood with a sustainable alternative, so forests can remain intact and fungi can keep their favorite place to live.

Getty Images

Students will then disperse in opposite directions to look for Card 1. Once found, the finder will use their silent signal to call their group over. The finder cannot move until the entire group has arrived. The card will then be passed around for all to read. Each card contains an activity that students must complete without speaking before moving on to the next card. Once the activity is complete, students will keep the card and disperse to look for Card 2. Repeat this sequence until groups have found all the cards and have completed all of their tasks.

4. Closing

15 minutes

Instructions

Ask students whether working together in the '*Talking Fungi*' activity was helpful for their survival as a fungus. Why or why not? Reiterate the importance of hyphae communicating with the whole mycelium network in order to help the fungus meet their needs.

Ask students what would happen to fungi in the takayna / Tarkine if the climate became drier. What if tree cover was reduced? Could fungi still communicate? Could fungi still survive? Why or why not?

Optional: Invite students to consider how their region would look if it had the same climate as the takayna / Tarkine. Using the neighborhood photos from '*Thinking Cap*', invite students to draw a new image showing the same scene with a takayna / Tarkine climate instead, showing above ground changes (i.e., tree cover) and below ground changes (i.e., mycelium) in the artwork.

Lesson 4 | Grade 6-8

Making Room for Life

This lesson is recommended after watching ***Fungi: Web of Life***.

NGSS Disciplinary Core Ideas

LS1.B Growth and Development of Organisms

LS1.C Organization for Matter and Energy Flow in Organisms

LS2.B Cycle of Matter and Energy Transfer in Ecosystems

LS2.C Ecosystem Dynamics, Functioning, and Resilience

ESS3.C Human Impacts on Earth Systems

Lesson Length

4 hours, 5 minutes

Lesson Summary

Students will examine the role of fungi as decomposers, through a large group game and an experiment on plant growth.

1. Thinking Cap

20 minutes

Materials

- Blank paper x 1 per student
- Drawing utensils
- Items from home (see '*Instructions*')

Instructions

Share with students that we all have items that accumulate in our lives like clothing, books, electronics, and more.

If we kept every item we've been given since birth, what would the inside of our homes look like? Hand out paper and drawing utensils. Have students choose a room in their home and draw it filled up with as many items as they can remember having from birth to today. How many items are piled up? Ask students how keeping all of their items since birth could impact their daily life. Could they move around in their space? Could they find what they need?

Ask students where their items have gone over time. Share that many of the items we accumulate do not break down easily. Instead, when we throw them away, they pile up in landfills and remain there for decades.

Mycelium has been fine-tuned over a billion years of evolution for one primary purpose: to consume. - Merlin Sheldrake[6]

Invite students to clear space in their home by choosing one item belonging to them that they no longer need and bringing it to class. Encourage other classes to do the same and make a collection point in the school. Source a local charity in need of second-hand items and donate the collection.

2. Breaking Down
1 hour

Materials

- Aerial map of the schoolyard/neighborhood x 1 per group*
- Old log (optional)
- Clipboard x 1 per group
- Writing utensils

**Note: Divide the map into 25 equal squares (5x5 grid), and label each square 1-25.*

Instructions

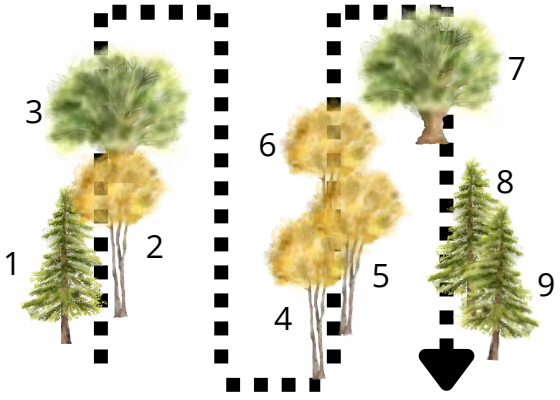
Ask students if they have noticed natural materials piling up outside. Are there stacks of fallen trees or deceased animals piling up in their neighborhood? If not, ask students where these beings have gone.

Take students outside and find an old log, if possible. Share that molecules in wood called **lignin** are difficult to break apart. Fungi are one of the only groups of organisms that can break down or **decompose** lignin. Ask students why fungi would want to break down lignin. *Response: to get nutrients.*

Invite students to gently touch the log. Is it hard or soft? A soft log is a sign that a mycelium is present in the wood, digesting the lignin. Share that if there were no fungi to break down wood like this log, the landscape would look very different.

Students will form groups of three or four. Hand out a map, clipboard, and writing utensils to each group. Assign each group one 'zone' on the map that is accessible and take students outside to their zone.

Students will now estimate the number of trees that would pile up in this area if there were no fungi to break them down. To do this calculation, students will count the number of trees in their assigned zone and record the data on their map. To count the trees, students may use a sweeping pattern, a zig-zag pattern, or a different pattern of their choice.



Once the trees have been counted, groups will gather and record the counts from each sampled zone on their maps.

Lesson 4 | Grade 6-8

Making Room for Life

To get nutrients, plants and animals put food directly **into** their body. Fungi get nutrients by eating food **outside** their body. They start by growing into their food, dissolving it, and then absorbing the nutrients.

Add together the total number of trees and divide by the number of zones sampled. The result will be an estimated number of trees per zone. Multiply the estimated number of trees by 25 to calculate the estimated number of trees in the entire area.

With the number of trees calculated, ask students how a pile of these trees might impact the people or other living beings who currently use this space. How would their movement change? Are they still able to meet their needs?

Knowing that fungi *are* present in this space and *are* decomposing the wood, students will play a game to model the flow of nutrients between fungi and other organisms.

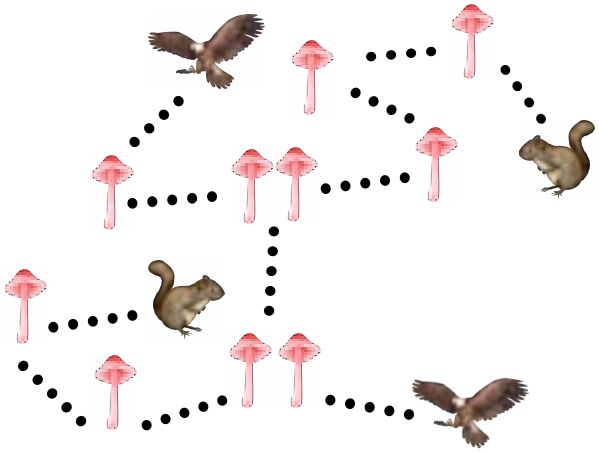
Assign students the role of either wood/lignin, fungi, squirrels, or eagles. Aim for 10 students to be wood/lignin, 5 as fungi, 5-7 as squirrels, and 2-3 as eagles (or similar proportions based on class size).

To begin, have 'wood/lignin' students form pairs, spread out in the play area, and stand back to back. Release 'fungi' into the game. Fungi will go to a lignin pair and squeeze between them, breaking them apart.

The broken down 'lignin' will lay down on the ground to represent nutrients going into the soil. 'Fungi' will lay down between them to absorb the nutrients. When all three students are laying down, they turn into mushrooms, choosing a shape of their choice to make with their bodies. Since mushrooms pop up in various places, mushrooms may move around the play area to simulate mushrooms sprouting.

Once a few mushrooms have formed, release the 'squirrels'. 'Squirrels' receive nutrients from mushrooms and tag them to eat. Eaten mushrooms lay down. After a minute, release 'eagles' to tag the squirrels, who they eat for nutrients. Eaten squirrels will freeze.

Once all squirrels are tagged, pause the game and give the following instructions: *Now that all the squirrels have been eaten, the eagles no longer have food and have all perished too. Fungi (mushrooms) must now work together to reach the deceased squirrels and eagles, and break down their bodies.*



> There is a sacred balance that exists between the rotten and the reborn, one cannot exist without the other. Fungi are the catalysts of this transformation. - Fungi Foundation [7]

Lesson 4 | Grade 6-8

Making Room for Life

To reach the animals, 'fungi' will slowly move toward one another and link arms or connect in a way that feels comfortable for them. They are now a mycelium! More than one 'fungus' can link to an arm. After 30 seconds, 'fungi' can link to 'eagles' and 'squirrels'. When the animal is linked by 'fungi', they lay down to return to the soil. The game ends when all animals have been tagged by 'fungi'.

Debrief by asking students which plants and animals are impacted if there are no fungi in the area. Reiterate that in addition to natural materials piling up if there are no fungi breaking them down, entire food webs are disrupted.

3. Plastic Pile Up*

2 hours, 30 minutes | over several periods

*Note: This activity may be done inside using pots or trays with soil if no suitable outdoor space is available.

Materials

- Triple mix soil (or similar) x 4 large bags
- Easy/fast growing seeds (i.e., radish, calendula, broccoli, cucumber, etc.)
- Watering can x 5, shared
- Cardboard
- Various plastic items from recycling bins
- Wood skewers x 8 per group
- Water, as needed
- Trowel x 1 per group
- Blank paper
- Writing utensils
- Tape/glue/twine
- Ruler x 1 per group

Instructions

Fungi have an incredible ability to break down natural materials, as well as some that are human-made. Ask students to recall from ***Fungi: Web of Life***, which human-made materials fungi can dissolve. Plastic is one! Ask students why plastic piling up in the environment is harmful.

Gather students in pairs. Groups will collect plastic items from the school's recycling bins and create a 1 ft (L) x 1 ft (W) x 1 ft (H) plastic sculpture. The plastic pieces must be strongly secured together.

In a sunny spot outside in or near the schoolyard (with permission), each group will choose two plots. In Plot #1 and Plot #2, students will remove a thin layer of grass and soil using a trowel in a 1 ft x 1 ft square and replace it with a layer of cardboard, followed by a layer of triple mix soil. They will mark the edges of the square with skewers and plant the same number of seeds in each plot. In Plot #2, students will place their plastic sculpture on top of the soil and secure it to the wood skewers.

Lesson 4 | Grade 6-8

Making Room for Life

Good 'Morels'

How do you make space for the people in your life? Do you put down your device and ask about someone's day? Do you invite a new student in class to join your game? What can you set aside today to make room for someone in your life?

On a piece of paper, students will note how many seeds they planted in each plot and their predictions on how many seeds will sprout and how tall the sprouts will get by the end of two weeks (or longer).

Students will water their seeds twice per day and note their daily observations at each plot. Have sprouts appeared? How tall are they? What color are they? At the end of two weeks, students will recycle their sculpture and report on (either orally or in writing):

- The impact of plastic on the growth of their seeds and why there was or was not a difference.
- The living beings impacted if plants cannot grow.
- The living beings impacted by plastic left in the environment (i.e., animals eating plastic).
- The benefit(s) of having fungi dissolve plastic to make room for plant growth in the environment.

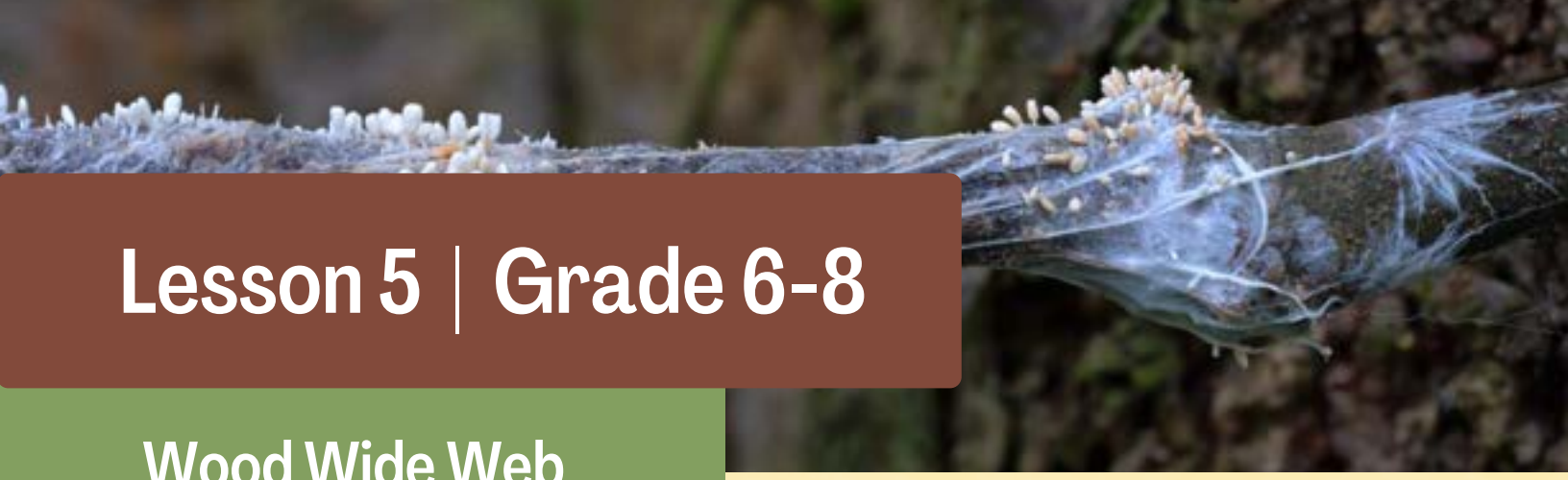
4. Closing

15 minutes

Instructions

Ask students to recall the flow of nutrients in the forest from the large group game. *Response: fungi ⟶ decompose wood to release nutrients ⟶ fungi absorb nutrients and form mushrooms ⟶ mushrooms give nutrients to squirrels ⟶ squirrels give nutrients to eagles ⟶ deceased eagles and squirrels give nutrients to fungi.*

Knowing that plastic is hazardous to many beings in the environment and that the plastic-eating fungus does not grow in all parts of the world, what could students do to prevent plastics from piling up in their community?



Lesson 5 | Grade 6-8

Wood Wide Web

This lesson is recommended after watching ***Fungi: Web of Life***.

NGSS Disciplinary Core Ideas

LS2.A Interdependent Relationships in Ecosystems

LS2.B Cycle of Matter and Energy Transfer in Ecosystems

LS2.C Ecosystem Dynamics, Functioning, and Resilience

Lesson Length

4 hours, 35 minutes

Lesson Summary

Students will examine the symbiotic relationship between fungi and plants with a dynamic simulation and creative writing.

1. Thinking Cap

20 minutes

Materials

- Blindfolds x 1 per pair of students (optional)

Instructions

Ask students where food is available in their neighborhood. Do they go to a grocery store, market, farm, or somewhere else? How do these places let potential customers know where they are located and what they are selling?

Share with students that **mycorrhizal fungi** have a **symbiotic** relationship with plants. The plants give nutrients to the fungi and in return, the fungi give nutrients to the plants. Ask students how plants let fungi know that they have food to give.

Gather students into pairs in a large open space (i.e., a field). One partner is a plant and the other is a fungus. Fungi will form a line at one end of the area and put on a blindfold or close their eyes. Their plant partners will form a line on the other side of the area, facing the fungi in a random order.

Plants will then call out a color and fungi will slowly move toward their partner, following the sound of their partner's voice. The round ends when all fungi have found their plant.

> What goes on beneath a forest floor is just as interesting - and just as important - as what goes on above it. A vibrant network of nearly microscopic threads is recycling air, soil, and water in a continuous cycle of balance and replenishment. - Suzanne Simard [8]

Lesson 5 | Grade 6-8

Wood Wide Web

For the next round, fungi will tell their plant their favorite food and line up at the opposite end of the area. Plants will call out their partners' favorite food and the fungi will once again find their plant partner with eyes closed. The round ends when all fungi have found their plant partner.

Ask fungi if it was easier to find their plant when they announced a color or when the plant announced their favorite food. Share that plants use chemical signals to announce to fungi that they have food to give.

2. Sharing Nutrients

2 hours, 30 minutes | over several periods

Materials

- Medium-sized pots x 4 per group
- Mycorrhizae-infused soil x 2 large bags
- Regular top soil x 2 large bags
- Fast growing seeds, minimum two types (i.e., radish, basil, calendula, marigolds, etc.)
- Spray bottle x 5, shared
- Popsicle sticks (or equivalent) x 40
- Water, as needed
- Buckets x 2
- Writing utensils
- Blank paper

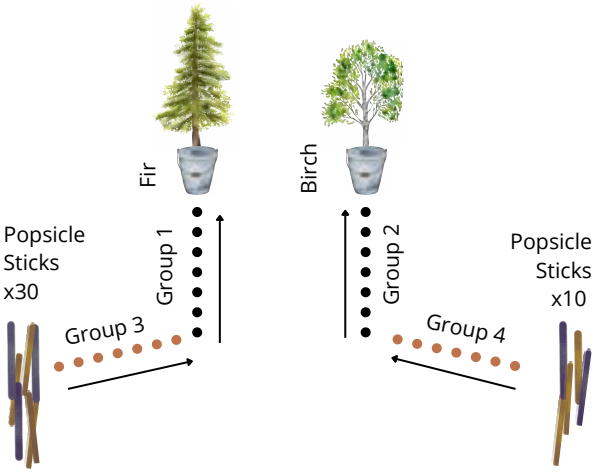
Instructions

Share with students that the original roots of plants were made of fungi and over millions of years, plants developed roots of their own.

Despite this evolutionary change, 90% of plants still rely on fungi to connect to their roots and shuttle nutrients to the plant. This underground transport network is often referred to as the '**wood wide web**.'

Place thirty popsicle sticks in one corner of the room and place ten popsicle sticks in the adjacent corner. Divide students into four groups. Group 1 will be the root of a Douglas Fir tree. They will stand in a line near the middle of the room where they cannot reach the sticks. The student farthest from the sticks will hold a bucket.

Group 2 will be the root of a young Birch tree, standing parallel to the Fir without being able to reach the Fir or the ten popsicle sticks in the adjacent corner. The student farthest from the ten sticks will hold a bucket. Groups 3 and 4 will be fungi. Group 3 will form a line connecting the thirty popsicle sticks to the end of the Fir root and Group 4 will form a line from the ten popsicle sticks to the Birch root.



Lesson 5 | Grade 6-8

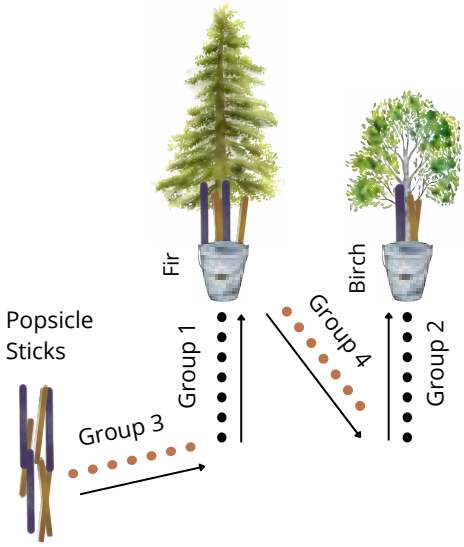
Wood Wide Web

Under each footstep, hundreds of kilometres of hyphae weave their way through the soil. If you were to stretch out all of the hyphae on Earth, it would span half the width of the Milky Way galaxy.

Explain that popsicle sticks represent nutrients in the soil. Both trees need twenty nutrients to survive. Since the trees cannot reach nutrients themselves, fungi - who have formed a mycelium - will pass nutrients to the trees.

The fungi closest to the sticks will begin by picking up a stick and passing it to the next fungus in line until they reach the tree root. The student at the end of the tree root will accept the nutrient and pass it up the root to their tree, dropping it in the bucket, which represents the above-ground tree.

Once the nutrients have run out for the Birch tree, pause the game. Explain that the Birch is no longer receiving nutrients, but needs ten more nutrients to survive. Ask if the Douglas Fir has ten nutrients they could give the Birch, while still having twenty for themselves. Give students a moment to count what they have in the Fir tree bucket and what is left to collect.



When they conclude that the Fir *can* give ten nutrients, the Birch fungi will form a line between the Fir bucket and the Birch root tip. Birch fungi will move ten sticks from the Fir bucket to the Birch root. End the simulation when each tree has twenty nutrients.

Ask students how the Fir and Birch benefited by partnering with fungi. Ask what kind of nutrients plants give fungi in return. Share that plants give fungi sugars to eat, which are made during photosynthesis.

Students will then test this partnership. Gather students into groups of four and hand out pots, mycorrhizae soil, top soil, and seeds. Fill spray bottles with water. Label the pots 1-4. Label the two different seed packs A and B.

- Pot #1 will be filled with mycorrhizae soil and planted with seeds from pack A.
- Pot #2 will be filled with top soil and planted with seeds from pack A.
- Pot #3 will be filled with mycorrhizae soil and planted with seeds from pack B.
- Pot #4 will be filled with top soil and planted with seeds from pack B.

Students will place the pots in a sunny location and using a spray bottle, will water their seeds with the same amount of water (decided in advance) twice a day.

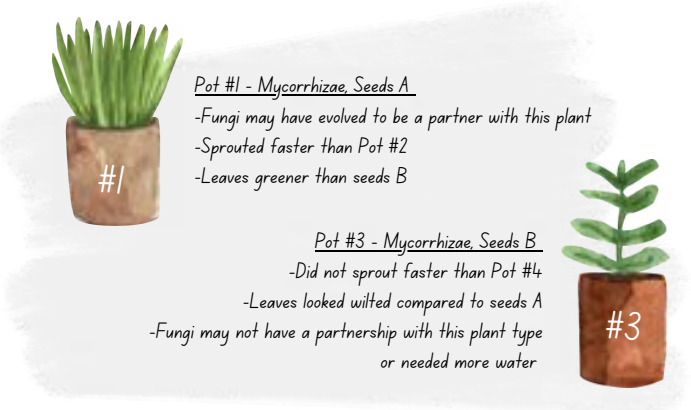
> A mycelial network is a map of a fungus's recent history and is a helpful reminder that all life-forms are in fact processes not *things*. - Merlin Sheldrake [9]

Lesson 5 | Grade 6-8

Wood Wide Web

On blank paper, students will note how many seeds they planted in each pot and note their daily observations. Have sprouts appeared? How many? How tall are they? How many leaves do they have? What color are the leaves? Continue watering and observing for a minimum of two weeks. At the end of this time, ask students to illustrate and/or write the results of their experiment, indicating:

- Whether seeds in the mycorrhizae soil grew faster or slower and why.
- Whether one type of seed grew better in the mycorrhizae soil and why.
- If they found no differences in growth between the soils, why might that be? Could fungi be present in both soils? How could they tell?
- What conditions could be changed in a future experiment to encourage mycorrhizae/fungi to thrive in the soil? Recall temperature and precipitation preferences of fungi from ***Fungi: Web of Life***.
- Their overall evaluation (one or two sentences) on whether mycorrhizae soil benefitted the plants they grew.



3. Mycelium Stories

1 hour, 30 minutes

Materials

- Map of the local community x 1 per student • Writing utensils • Ruler
- Photos of takayna / Tarkine x 1 per student (Appendix I) • Scissors
- Blank 8.5x11-inch paper x 2 per student
- Glue • Tape

Instructions

Hand out maps of the community and ask students to circle their school on the map. Then, draw lines from the school to all the places they have visited in the past month until they have created a snapshot of their recent movement and experiences.

Share with students that **hyphae** grow from the tip outward. Trace backwards from the tip and you will find all of the past experiences of the fungus. The entire mycelial network will show which beings the fungus has given nutrients to and which beings they have received nutrients from.

Hand out photos of the takayna / Tarkine. Students will mark where an imaginary spore has landed and a mycelium has formed. From this point, students will draw an imagined path of a mycelium moving through the forest.

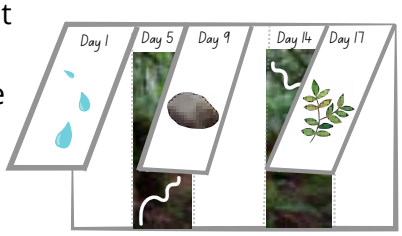
Lesson 5 | Grade 6-8

Wood Wide Web

Good 'Morels'

What services are offered in your community to support those who cannot get what they need on their own? Choose a non-profit organization to research and learn how you can get involved. Consider volunteering at the organization or fundraising to help maintain the services in your community. A mutually beneficial symbiotic relationship might even form!

Hand out two pieces of 8.5x11-inch paper and have students fold them in half on the long side. Mark every 2-inches along the bottom and cut 2x4-inch rectangles on the front fold only to make three flaps. Cut takayna / Tarkine photos into 2-inch strips and glue strips between the flaps.



Students will tape their folded paper side-by-side and create a timeline showing the experience of a mycelium over the span of a month in the takayna / Tarkine. The mycelium should interact with five living beings (i.e., plants or animals) and one element of the Earth (i.e., water or rocks). Interactions will be drawn on top of the flap, with a short story on whether the fungus gave or received nutrients during the interaction under the flap.

4. Closing

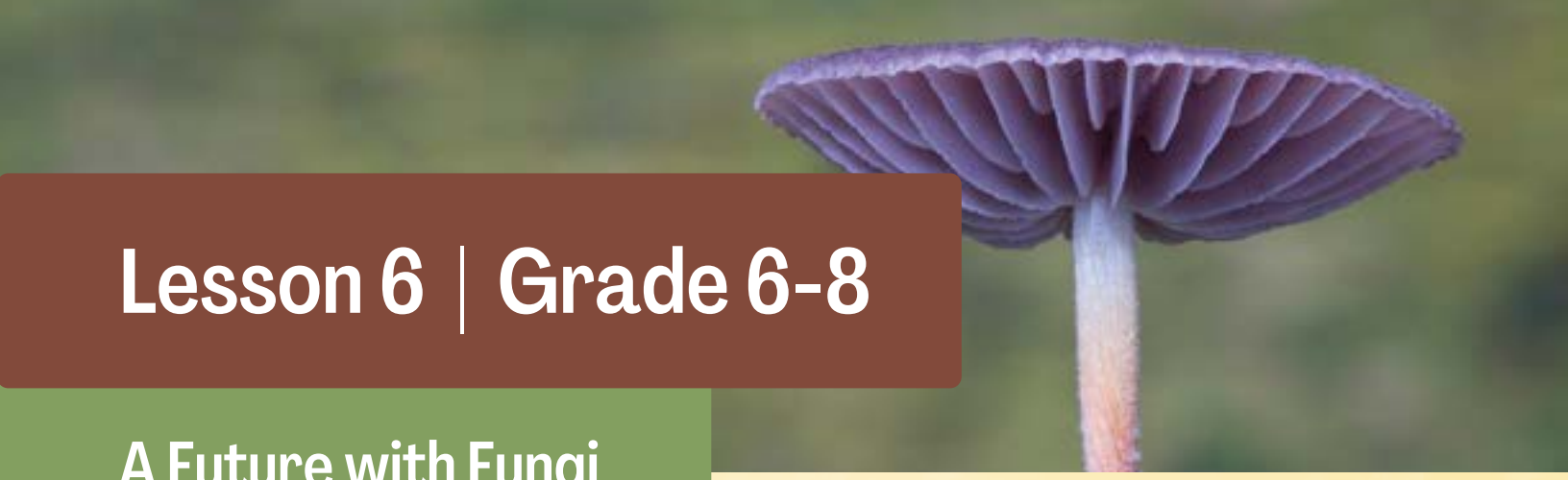
15 minutes

Instructions

Ask students how imagining the experiences of a mycelium has helped them better understand the life of fungi. How does it feel to know that mycelial networks are growing and moving beneath them?

Ask students how they could be in a mutually beneficial symbiotic relationship with fungi. Make a list of what fungi offer to them and what they could offer to fungi in return, recalling what fungi need to survive and the challenges they are facing in ***Fungi: Web of Life***.

Getty Images



Lesson 6 | Grade 6-8

A Future with Fungi

This lesson is recommended after watching ***Fungi: Web of Life***.

NGSS Disciplinary Core Ideas

LS2.B Cycle of Matter and Energy Transfer in Ecosystems

LS2.C Ecosystem Dynamics, Functioning, and Resilience

LS4.D Biodiversity and Humans

ETS1.B Developing Possible Solutions

ESS3.C Human Impacts on Earth Systems

Lesson Length

5 hours, 25 minutes

Lesson Summary

Students will examine the various benefits fungi offer the world through outdoor exploration and dramatic arts.

1. Thinking Cap

40 minutes

Materials

- Camera (phone is suitable) x 1 per pair
- Device with internet
- Writing utensils
- Blank paper x 1 per student
- Clipboard x 1 per student

Instructions

Ask students who the unseen helpers are in their life, starting with people. For example, who grew the food they are eating today? Who made the clothes they are wearing? Who cleaned the space they are in?

Ask students who their unseen helpers are in the more-than-human-world. For example, gut bacteria are breaking down food we eat and rain is helping trees grow and produce oxygen that we need to breathe.

Take students outside and gather into pairs. Hand out a clipboard, blank paper, and writing utensils to each student. Students will identify a being or part of the natural world that is helping them in everyday life, but often goes unnoticed. Students will take a picture of the 'helper' and write a social media post using the blank paper to express their gratitude.

Incorporating these fungi into our lives and our environment strengthens the defense of the entire ecosystem. - Paul Stamets [10]

Students may wish to use the following template for their gratitude post:

Dear [insert name of being/part of the natural world], unseen helper of the planet,

Thank you for [insert how they are helping]. Without you, [insert what would happen and who would be impacted if the helper did not exist]. We see you and we appreciate you.

Create a class social media account and post the photos taken outside along with the notes of gratitude to share with guardians and peers.

2. Superhero Fungus

1 hour, 30 minutes

Materials

- Clipboard x 1 per student
- Blank paper x 1 per group
- Superhero Fungus Cards (Appendix J) x 2 sets
- Writing utensils

Instructions

Fungi are often perceived as unseen helpers, contributing to a healthy ecosystem by breaking down materials and releasing nutrients, shuttling nutrients to plants in need, holding the soil together, and more. They are also a source of food and medicine for humans and more-than-human animals alike.

In advance, place one set of Superhero Fungus Cards at the outdoor locations indicated on the cards. Take students outside and arrange in pairs. Give each pair a different Superhero Fungus Card from a second set. Pairs will solve the riddle on their card and go to the location where they think the next card is hidden. When they find a new card, they will solve the riddle, leave this card, and move on to the next location.

After 15-20 minutes or when groups have found every card, gather students together and arrange into groups of four or five. Groups will choose one or more ways that fungi help maintain diverse ecosystems (based on information from the Superhero Fungus Cards) and create a three-minute skit to tell the story of a superhero fungus who is saving the planet. The skit should include how the fungus is saving the planet, which beings benefit from their superpowers, and how humans can help protect the fungus, so we can have a future with fungi in it. Provide blank paper for students to write their script. Practice and perform the skits for younger classes.

Lesson 6 | Grade 6-8

A Future with Fungi

The most famous fungal medicine – penicillin – has saved billions of lives by fighting bacterial infections. Under the microscope, we can see penicillin holding back bacterial growth.

3. Can Fungi Fix It?

3 hours | over several periods

Materials

- Music playing device • Chairs x 3-4
- 'Can Fungi Fix It?' Topics (Appendix K)
- 'Can Fungi Fix It?' Evaluation Sheet (Appendix L) x 8 sheets per student
- 'Can Fungi Fix It?' Evaluation Response Cards (Appendix M) x 1 card per student
- Writing utensils

Instructions

Recall from ***Fungi: Web of Life*** that fungi are being used as innovative solutions to solve environmental challenges due in part to their ability to adapt to their environment.

Tell students that there is a new fictional video series called 'Can Fungi Fix It?', where guest experts share how fungi can solve big environmental challenges.

Show Topics

Climate Change
Disease
Food Security
and more!

Gather students into eight groups. One group member will be a host for the series and remaining students will be guest experts. After choosing a topic (from Appendix K), they will create a 5-minute live segment.

The host will:

- Play a theme song (~5 seconds)
- Explain the environmental challenge, along with it's cause and the consequences if it is not fixed (~1 minute)
- Ask the audience to say "Can Fungi Fix It?"
- Introduce the guest 'experts'
- Share the cost of the solution after the guests have spoken (~20 seconds)
- Take questions from the audience before the evaluation (~1 minute, 30 seconds)

The guest expert(s) will:

- Share about an organization/company or person trying to solve the challenge with fungi (~30 seconds)
- Explain the solution and the adaptations of fungi that are enabling them to help solve this problem (~30 seconds)
- Show photos of the fungi used in the solution or photos of the company's products (~30 seconds)
- Suggest a change in human behavior needed to help solve the problem while the fungus-based solution becomes more accessible globally (~30 seconds)

Good 'Morels'

There are many unseen helpers supporting us in everyday life. Who are the helpful friends, family, and/or neighbors in your life? Offer thanks to those who care for you, support you, and love you exactly as you are. In what way are you an unseen helper? How are your unseen actions contributing to the wellbeing of your community?

Hand out a 'Can Fungi Fix It?' Evaluation Sheet to students who are not presenting along with writing utensils. These students will have 2-minutes to fill out the prompts after the segment has ended. Once complete, students will hold up their Yes/No evaluation card, indicating whether they think fungi can solve the problem. For students who said *yes*, the host will ask them to share one 'next step' needed to make the solution possible. For students who said *no*, the host will ask them for an alternative solution or changes to the solution that will help solve the challenge. The activity ends when all groups have presented.

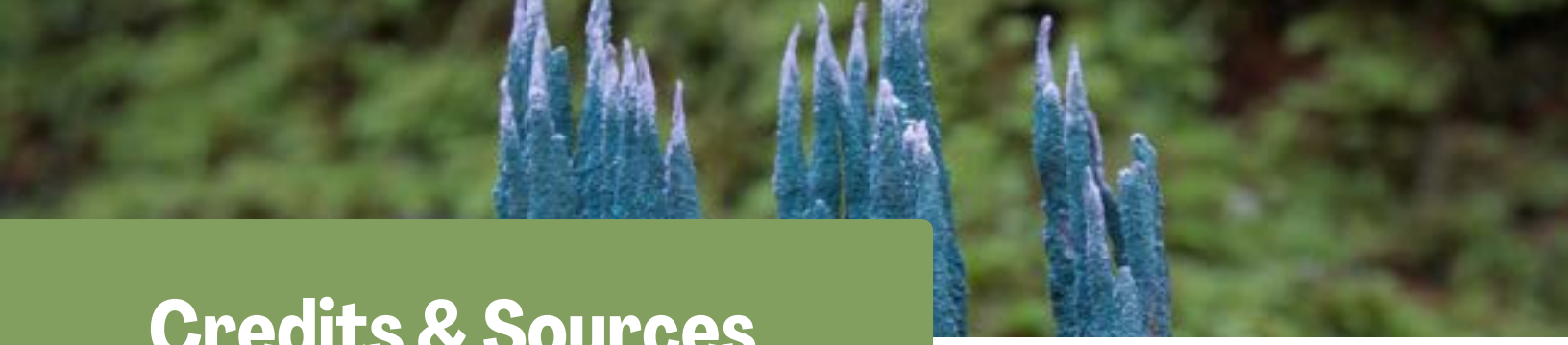
4. Closing

15 minutes

Instructions

Ask students why it is imperative that we have a future with fungi in it. Recall the many ways that fungi help the human and more-than-human world. Knowing how important fungi are for the health of the planet, how could students bring more awareness to these often unseen helpers? Who else should know about the benefits of fungi in their community? Who are making decisions that impact the survival of fungi?

While the scale of global environmental challenges may seem too big for an individual to solve, we can always adapt like fungi and find a way to help. In recalling the changes in human behavior needed to solve some of these challenges, identify a practical action students could take as a class or as individuals to alleviate part of the challenge. With the support of teachers and peers, assist students in taking action.



Credits & Sources

Written and designed by Jess Pelow, Back to Earth Science Inc. | backtoearthscience.com

Edited and reviewed by Dr. Tom May, Royal Botanic Gardens Victoria, Melbourne, Australia.

Photos of fungi and lutruwita / Tasmania by Steve Axford, unless otherwise noted.

Fungi: Web of Life is a K2 Studios release and Stranger Than Fiction Films production.

Back to Earth Science Inc. is located on the traditional territory of the Anishinaabek and Haudenosaunee. K2 Studios is situated within the traditional territory of the Gabrielino/Tongva Nation. Stranger Than Fiction Films acknowledges the Indigenous Peoples of all the lands on which this film was made. We pay our deep respect to the Elders and Ancestors, and to the vibrant cultures that are present on these lands today.

Learn more about ***Fungi: Web of Life***, a giant screen format film at www.fungimovie.com.

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APPENDIX A

Lesson 1 - Images of Fungi

SET #1 - Page 1 of 3

Hairy Oyster Mushroom / *Panus lecomtei*

Bristly Tropical Cup / *Cookeina tricholoma*

Brown Forest Cup / *Plectania campylospora*

Violet Coral / *Clavaria zollingeri*

Green Elfcup / *Chlorociboria aeruginosa*

Jellybabies / *Leotia lubrica*

Lesson 1 - Images of Fungi

SET #1 - Page 2 of 3

Aporpium strigosum

Rhubarb Bolete / *Boletus obscurecoccineus*

Auricularia delicata

Leathery Goblet / *Cymatoderma elegans var. lamellatum*

Strawberry Bracket / *Aurantiporus pulcherrimus*

Fragile Dapperling / *Leucocoprinus fragilissimus*

Lesson 1 - Images of Fungi

SET #1 - Page 3 of 3

Coprinopsis pulchricaerulea

Anemone Fungus / *Aseroe rubra*

Flame Fungus / *Clavaria miniata*

Fluted Bird's Nest / *Cyathus striatus*

Collared Earthstar / *Geastrum triplex*

Yellow Netted Stinkhorn / *Phallus multicolor*

Lesson 1 - Images of Fungi

SET #2 - Page 1 of 3

Hairy Oyster Mushroom / *Panus lecomtei*

Bristly Tropical Cup / *Cookeina tricholoma*

Brown Forest Cup / *Plectania campylospora*

Violet Coral / *Clavaria zollingeri*

Green Elfcup / *Chlorociboria aeruginosa*

Jellybabies / *Leotia lubrica*

Lesson 1 - Images of Fungi

SET #2 - Page 2 of 3

Aporpium strigosum

Rhubarb Bolete / *Boletus obscurecoccineus*

Auricularia delicata

Leathery Goblet / *Cymatoderma elegans var. lamellatum*

Strawberry Bracket / *Aurantiporus pulcherrimus*

Fragile Dapperling / *Leucocoprinus fragilissimus*

Lesson 1 - Images of Fungi

SET #2 - Page 3 of 3

Coprinopsis pulchricaerulea

Anemone Fungus / *Aseroe rubra*

Flame Fungus / *Clavaria miniata*

Fluted Bird's Nest / *Cyathus striatus*

Collared Earthstar / *Geastrum triplex*

Yellow Netted Stinkhorn / *Phallus multicolor*

APPENDIX B

Lesson 1 - Gills, Pores, and Teeth Images

Gills

Pores

Teeth & Spines

APPENDIX C

Lesson 1 - Comparing Fungi Worksheet

Mushroom 1

Sketch the mushroom below.

Where is the mushroom growing? (**circle answers**)

GRASS LOG TREE WOOD CHIPS OTHER:

Is the mushroom in a spot that is... (**circle answers**)

SUNNY SHADY WET DRY SLOPED FLAT

Mushroom 2

Sketch the mushroom below.

Where is the mushroom growing? (**circle answers**)

GRASS LOG TREE WOOD CHIPS OTHER:

Is the mushroom in a spot that is... (**circle answers**)

SUNNY SHADY WET DRY SLOPED FLAT

Mushroom 3

Sketch the mushroom below.

Where is the mushroom growing? (**circle answers**)

GRASS LOG TREE WOOD CHIPS OTHER:

Is the mushroom in a spot that is... (**circle answers**)

SUNNY SHADY WET DRY SLOPED FLAT

Mushroom 4

Sketch the mushroom below.

Where is the mushroom growing? (**circle answers**)

GRASS LOG TREE WOOD CHIPS OTHER:

Is the mushroom in a spot that is... (**circle answers**)

SUNNY SHADY WET DRY SLOPED FLAT

Comparing Fungi 1 & 2

Compared to Mushroom 2, is Mushroom 1 (circle answers):

TALLER SHORTER ROUNDER FLATTER DULLER SHINIER SMOOTHER BUMPIER HIGHER UP ON THE GROUND

What characteristics do they have in common?

What characteristics are different between them?

How might these differences be helping the individual survive better?

Do you think these two mushrooms are from the same species of fungus? Why or why not?

Comparing Fungi 3 & 4

Compared to Mushroom 4, is Mushroom 3 (circle answers):

TALLER SHORTER ROUNDER FLATTER DULLER SHINIER SMOOTHER BUMPIER HIGHER UP ON THE GROUND

What characteristics do they have in common?

What characteristics are different between them?

How might these differences be helping the individual survive better?

Do you think these two mushrooms are from the same species of fungus? Why or why not?

APPENDIX D

Lesson 2 - Growth of Fungi Game Cards

Card #1 - Side 1 of 2

Getty Images Signature

SPORE

Collect 2 water.

Give water to the game leader.

Congratulations! You have grown into hyphae. Flip this card over.

Getty Images Signature

SPORE

Collect 2 water.

Give water to the game leader.

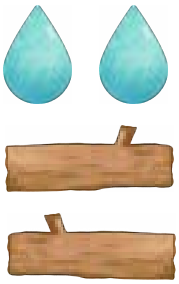
Congratulations! You have grown into hyphae. Flip this card over.

Lesson 2 - Growth of Fungi Game Cards

Card #1 - Side 2 of 2

HYPHAE

Collect 2 water and 2 food.

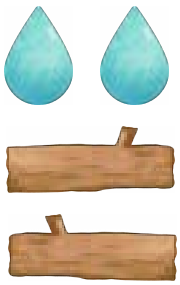


Give food and water to the game leader.

Congratulations! You have grown into a mycelium. Receive a mycelium card from the game leader.

HYPHAE

Collect 2 water and 2 food.

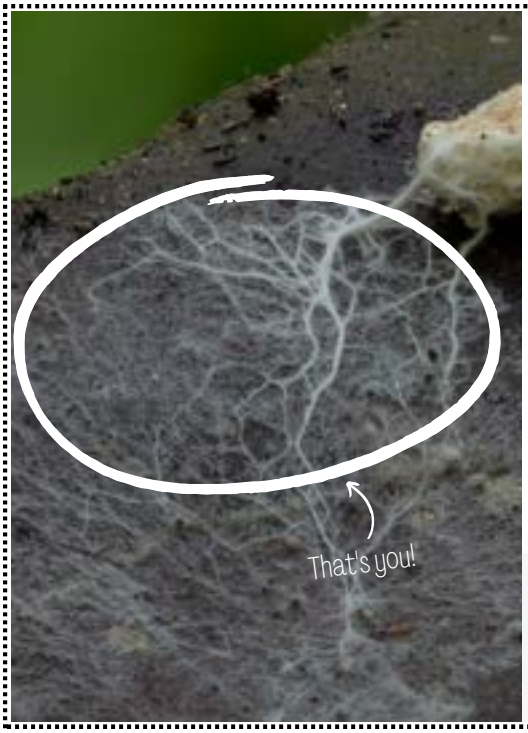


Give food and water to the game leader.

Congratulations! You have grown into a mycelium. Receive a mycelium card from the game leader.

Lesson 2 - Growth of Fungi Game Cards

Card #2 - Side 1 of 2



MYCELIUM

Find a student with a matching mycelium image.

Collect 3 water and 1 food.

Show matching mycelium to the game leader and hand over water and food.

Congratulations! You have grown into a mushroom. Flip this card over.

MYCELIUM

Find a student with a matching mycelium image.

Collect 3 water and 1 food.

Show matching mycelium to the game leader and hand over water and food.

Congratulations! You have grown into a mushroom. Flip this card over.

Lesson 2 - Growth of Fungi Game Cards

Card #2 - Side 2 of 2

MUSHROOM

It's time to spread your spores! Hide your original 'SPORE' card in the play area.

Congratulations! You have completed your life cycle and have decomposed. Return this card to the game leader.

MUSHROOM

It's time to spread your spores! Hide your original 'SPORE' card in the play area.

Congratulations! You have completed your life cycle and have decomposed. Return this card to the game leader.

APPENDIX E

Lesson 2 - Fungus Life Cycle Cards

Full Set - Side 1 of 2

Lesson 2 - Fungus Life Cycle Cards

Full Set - Side 2 of 2

Mycelium	Hyphae	Spores
Nutrients are transported from soil to Douglas Fir trees through **mycelia**.	Squirrels eat mushrooms! They sometimes dry the **mushrooms** and store them to eat later in winter.	**Mushroom**
Bees drink droplets from certain **mycelia**, which have been shown to reduce viruses in bee populations.	*Macrotermes* termites farm a fungus called *Termitomyces* that produces **mushrooms** eaten by the termites.	**Hyphae** grow into logs and turn the wood into nutrients by breaking it down.
Nutrients can be transported from Douglas Fir trees to Birch trees through **mycelia**.	When the Long-nosed Potoroo eats truffle-like fungi, the **spores** are dispersed through their scat.	**Hyphae** grow into fallen leaves and turn them into nutrients by breaking them down.

EXPERIMENT #1 WIND DISPERSAL

Materials

- Seeds, lightweight x 2-3
- Seeds, heavy x 2-3
- Tape x 8 medium strips
- Measuring tape

Instructions

Step 1. Students will predict which seed will travel the farthest by wind: a lightweight seed or a heavier seed.

Step 2. Using two strips of tape, mark an 'x' on the floor.

Step 3. Student A will stand on the 'x' and hold a lightweight seed in their palm.

Step 4. Student A will blow the seed out of their palm. Student B will watch where the seed lands and mark the landing spot with a piece of tape, labeled 'Trial 1 - Light'.

Step 5. Measure the distance between the 'x' and the tape and record this value on the worksheet.

Step 6. Repeat Steps 3-5 with a heavy seed, labeling the landing spot 'Trial 1 - Heavy'.

Step 7. Repeat Steps 3-6 a second time, labeling the landing spot 'Trial 2 - Light' and 'Trial 2 - Heavy' respectively.

PREDICTIONS & RESULTS

Which seed will travel the farthest? (circle)

LIGHTWEIGHT HEAVY

Lightweight Seed Results

Trial 1 - Light Measurement: _____

Trial 2 - Light Measurement: _____

Average Distance Blown (add the measurements together and divide by two):

Heavy Seed Results

Trial 1 - Heavy Measurement: _____

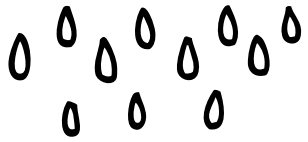
Trial 2 - Heavy Measurement: _____

Average Distance Blown (add the measurements together and divide by two):

Which seed traveled the farthest? (circle)

LIGHTWEIGHT HEAVY

EXPERIMENT #2 WATER DISPERSAL



Materials

- Seeds, lightweight x 30
- Pill bottles with lid
- Water bottle, filled with water
- Spoon
- Wide bowl/tray

Instructions

Step 1. Students will predict which cup depth will disperse more seeds when water is splashed into it.

Step 2. Place the spoon in the bowl/try.

Step 3. Put 5 seeds on the spoon.

Step 4. Hold the water bottle at least 3 feet above the bowl and pour a splash of water onto the seeds.

Step 5. Count how many seeds splashed out of the spoon and record the number under 'Spoon Results - Trial 1'.

Step 6. Clear all the seeds from the bowl and replace the spoon with the pill bottle lid. Repeat Steps 3-5, recording the results under 'Lid Results - Trial 1.'

Step 7. Clear all the seeds from the bowl and replace the lid with the pill bottle. Repeat Steps 3-5, recording the results under 'Pill Bottle Results - Trial 1.'

Step 8: Repeat all trials a second time.

PREDICTIONS & RESULTS

Which cup depth will disperse more seeds when water is splashed into it? (circle)

SPOON	PILL BOTTLE LID	PILL BOTTLE
Very Shallow	Shallow	Deep

Spoon Results

Trial 1 - # of seeds that splashed out: _____

Trial 2 - # of seeds that splashed out: _____

Average # of seeds splashed out (add the values together and divide by two):

Lid Results

Trial 1 - # of seeds that splashed out: _____

Trial 2 - # of seeds that splashed out: _____

Average # of seeds splashed out (add the values together and divide by two):

Pill Bottle Results

Trial 1 - # of seeds that splashed out: _____

Trial 2 - # of seeds that splashed out: _____

Average # of seeds splashed out (add the values together and divide by two):

Which cup depth dispersed more seeds when water was splashed into it? (circle)

SPOON	PILL BOTTLE LID	PILL BOTTLE
Very Shallow	Shallow	Deep

EXPERIMENT #3 ANIMAL DISPERSAL

Materials

- Sponge
- Mint extract
- Dried grass & leaves or equivalent
- Rocks or equivalent x 4
- Tape measure

Instructions

Step 1. Students will predict whether they will find a scented sponge under leaves.

Step 2. Measure out an area roughly 8 feet x 8 feet and mark the corners with rocks.

Step 3. Add several drops of mint extract to the sponge.

Step 4. Student A will sniff the sponge to learn the scent.

Step 5: Student B will place the sponge next to one of the rocks. They will add a thin layer of leaves or grass over top of the sponge and all the rock corners, so they look similar.

Step 6. Student A will go to each corner and sniff the leaves. They will point to the corner they think has the scented sponge. If they are incorrect, they will try again until they are successful. Record the attempts.

Step 7. Set up the rocks in a new spot with new leaves/grass to clear the mint scent. Repeat Steps 4-6. Students will then switch roles.

PREDICTIONS & RESULTS

Will a scented sponge be found under the leaves/grass in two attempts or less? (circle)

YES NO

Trial 1 - Student A

On which attempt was the sponge found? (circle)

FIRST SECOND THIRD FOURTH

Trial 2 - Student A

On which attempt was the sponge found? (circle)

FIRST SECOND THIRD FOURTH

Trial 3 - Student B

On which attempt was the sponge found? (circle)

FIRST SECOND THIRD FOURTH

Trial 4 - Student B

On which attempt was the sponge found? (circle)

FIRST SECOND THIRD FOURTH

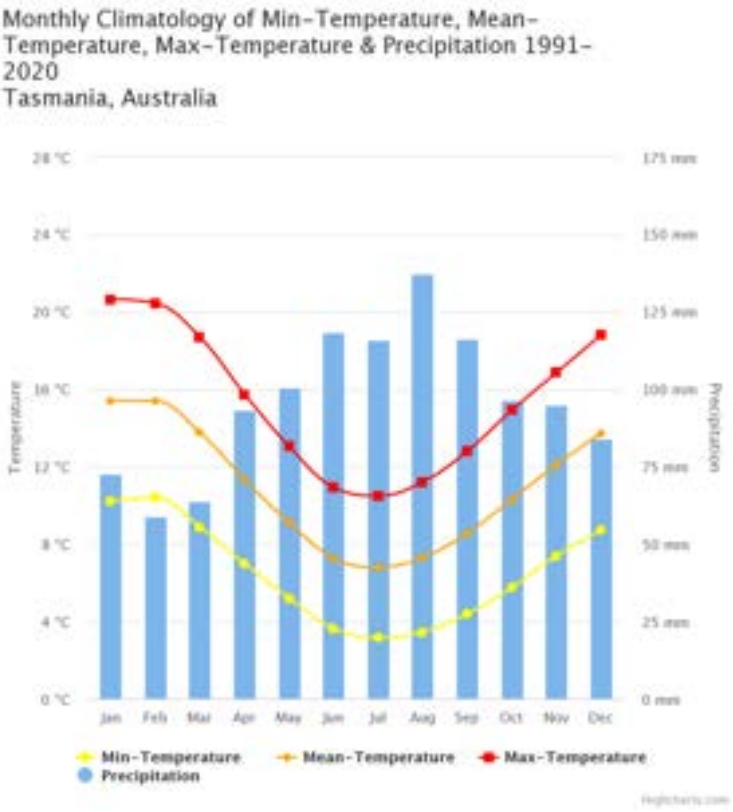
Was the scented sponge found under the leaves/grass in two attempts or less on average? (circle)

YES NO

APPENDIX G

Lesson 3 - takayna /Tarkine Climate and Tree Data

Temperature and Precipitation in lutruwita / Tasmania



SOURCE: climateknowledgeportal.worldbank.org

Tree Cover in lutruwita / Tasmania

SOURCE: globalforestwatch.org

takayna / Tarkine

APPENDIX H

Lesson 3 - Fungus Communication Cards

Full Set

Fungi prefer damp environments and are often found in the shade under the cover of trees. Rest in this shady spot for 30 seconds, looking and listening to the world around you. Then, look for fungi. Do you see any mushrooms? If yes, point them out to your group. Are there any other beings enjoying the shade here too?

Place Card 1 in the shade.

Getty Images Signature

It's been dry for weeks and you need water for mushrooms to grow. You start dispersing spores into the sky in hopes that they will form water droplets and fall back down as rain. As a group, do your best impression of releasing spores into the sky for 20 seconds.

Place Card 2 anywhere.

Did you know that you are a mycorrhizal fungus? You get food by connecting to the roots of plants and eating sugar that the plant made during photosynthesis. One by one, hug the nearest tree and offer thanks for giving you the nutrients you need to survive.

Place Card 3 near a tree.

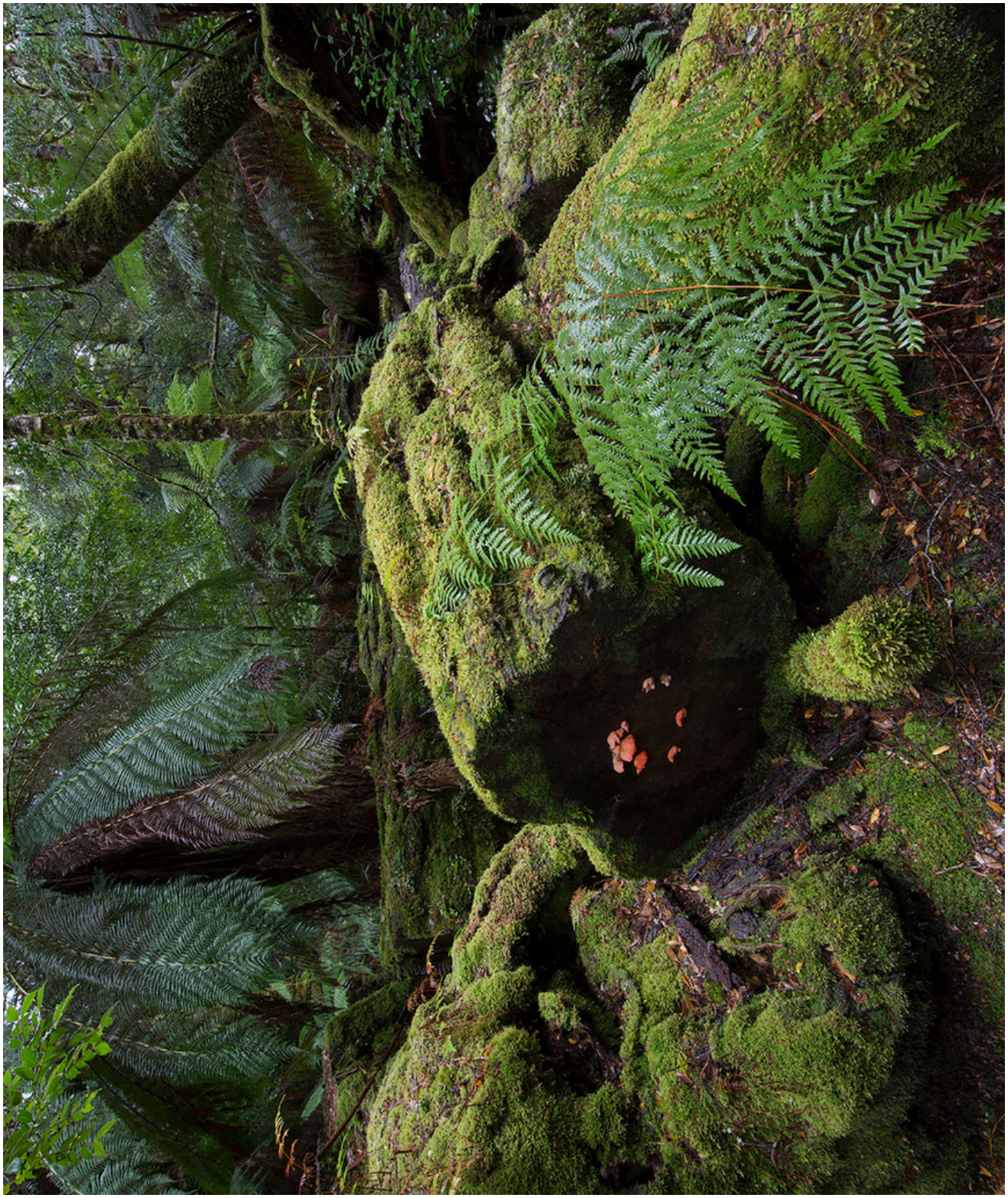
Other fungi get food from breaking down leaves, logs, and more and then absorbing the nutrients. With proper nutrients and water, mushrooms will sprout! Collect 4 natural items off the ground per student and as a group, silently create a piece of art in the shape of a mushroom in honor of the 'decomposer' fungi.

Place Card 4 anywhere.

APPENDIX I

Lesson 5 - Photos of takayna / Tarkine

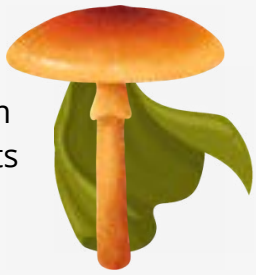
Lesson 5 - Photos of takayna / Tarkine



APPENDIX J

Lesson 6 - Super Hero Fungus Cards

Go to the tallest being in this area who breathes in carbon dioxide and breathes out oxygen. Fungi help this organism by transporting nutrients from the soil into their roots. Who are fungi helping?



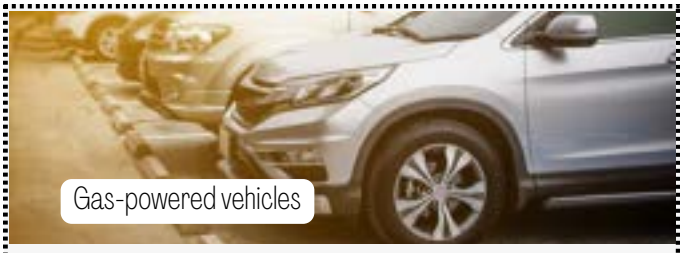
Place card near a mushroom.

When a tree falls to the ground, their trunk turns into small _____ that you can neatly stack in a pile. Fungi help clear the forest floor by breaking down these pieces and releasing the nutrients into the soil. What are fungi clearing off the forest floor?

Place card at the tallest tree in the play area.

These human-made machines emit thousands of kilograms of CO_2 into the atmosphere every year and are contributing to global climate change. Fungi can help prevent climate change by storing carbon underground. What machines are spewing out carbon?

Place card near a log or fallen branches.



Go to the being who introduced this lesson. Fungi have given this being food, like yeast that's made into bread, and medicine like penicillin to heal them if they are sick. What being has benefitted from food and medicine made by fungi?

Place card near a parking lot or vehicle, where it is safe to do so.

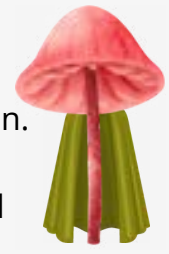
This being is a mix of an alga (or a bacterium) and a fungus, and often grows on rocks or wood. The alga photosynthesizes and gives sugar to the fungus, while the fungus provides protection and offers food too. Which being has a fungus as protection?

Place card with the instructor/teacher.

This human-made item can be made into bottles, rings, straws, and so much more. It is difficult to break down and sits in the environment for decades. It was recently discovered that some fungi *can* break it down! What item can fungi break down?

Place card near lichen, typically found on rocks or trees.

This structure was likely built from wood and bricks, so you could have a place to study. But extracting wood and stone can lead to deforestation. Fungi can help save these forests by replacing wood and stone as building materials! Which structure could be built from fungi in the future?



Place near a recycling bin.

When hyphae come together in a tight bundle and are inflated with water, _____ can form! Many animals eat these sporing bodies, like mammals and insects. What is the food source that fungi can make?

Place near the school/learning building.

APPENDIX K

Lesson 6 - 'Can Fungi Fix It?' Topics

Topic: Bee population decline due to mites

Solution Fungus: *Ganoderma resinaceum*

Case Study: Paul Stamets (Fungi Perfecti) and Steve Sheppard (Washington State University)

Topic: Carbon storage for climate change resilience

Solution Fungus: Various mycorrhizal fungi

Case Study: Loam Bio, Guy Webb

Topic: Harm to animals for leather in fashion

Solution Fungus: Various mycelia

Case Study: MycoWorks, Sophia Wang and Philip Ross

Topic: Meat industry links to climate change

Solution Fungus: Various mycelia

Case Study: Ecovative, Eben Bayer and Gavin McIntyre

Topic: Harm to animals for leather in fashion (shoes)

Solution Fungus: *Fomes fomentarius*

Case Study: nat-2

Topic: Cutting old growth trees to make instruments

Solution Fungus: Various mycelia

Case Study: Rosenkrantz, Rachel Rosenkrantz

Topic: Chemicals and toxins in the environment (and need for remediation)

Solution Fungus: Various

Case Study: Mushroom Mountain & Earth Repair

Topic: Build up of plastic and styrofoam packaging

Solution Fungus: Various mycelia

Case Study: Ecovative, Eben Bayer and Gavin McIntyre

APPENDIX L

Lesson 6 - 'Can Fungi Fix It?' Evaluation Sheet

'Can Fungi Fix It?' Evaluation

Group # **Topic:**

Do you think the solution is affordable? Yes No

Do you think the solution could work in every part of the world? If no, why not? Yes No

Does this solution have any disadvantages or negative impacts? If yes, what are the negative impacts? Yes No

Is there something you would change to make the solution better? If yes, what would you change? Yes No

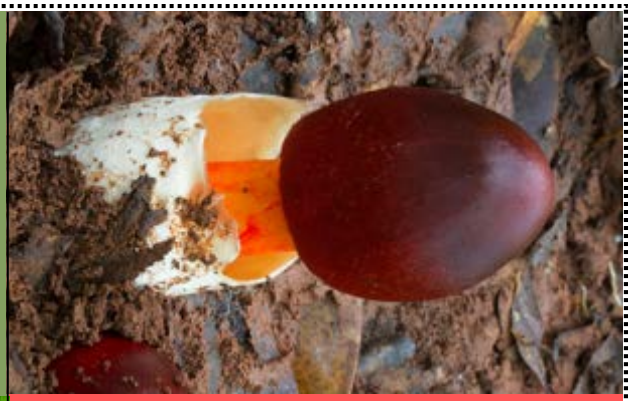
Will you try the suggested behaviour to help alleviate the challenge?

Yes No

APPENDIX M

Lesson 6 - 'Can Fungi Fix It?' Evaluation Response Cards

Yes



No

Yes

No