



Help the Plant Heroes protect our forests  
by slowing the spread of pests and diseases!

PLANTHEROES.ORG  
**ADVANCED  
ACTIVITY  
BOOK**

# ARMILLARIA SHOESTRING ROOT ROT



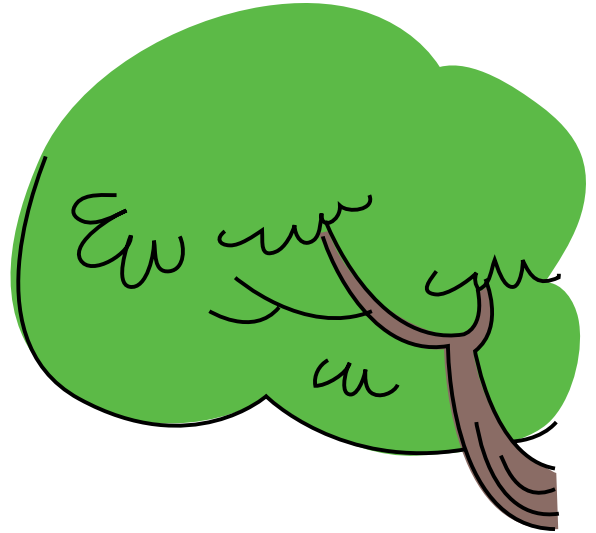
**BE A PLANT HERO!**  
Help the Plant Heroes  
slow the spread of  
Armillaria Shoestring  
Root Rot!



Plant  
Protection  
Program

AMERICAN PUBLIC GARDENS ASSOCIATION

# Meet the PLANT HEROES!



## LAURA WILKINS

From: Athens, Georgia  
Hobbies: playing the trumpet,  
gardening, studying ecology

## FRANKIE BARKER

From: Shrewsbury, Massachusetts  
Hobbies: climbing trees, camping

## NATE GREEN

From: Tacoma,  
Washington  
Hobbies: going on  
adventures, learning  
about fungi

## APONI STAR

From:  
Southeast  
Illinois  
Hobbies:  
learning  
more about  
entomology  
(the study of  
insects)



[plantheroes.org](http://plantheroes.org)

© 2021 American Public Gardens Association



The Plant Heroes are four friends who love spending time in nature more than anything else! They enjoy climbing trees, walking trails, and camping.

The heroes are learning about why our forests are in danger. There are insects and fungi that can impact trees, sometimes affecting the health of whole forests. Trees may become sick or die when they are weakened by an invasive species, a living thing that is introduced to a new environment where it can cause damage to existing organisms.

**Follow the Plant Heroes  
to learn the story of how  
they helped slow the  
spread of  
*Armillaria*  
“shoestring”  
root rot...**



[plantheroes.org](http://plantheroes.org)

© 2021 American Public Gardens Association

# Untangling the Mystery of Shoestring Root Rot



SUMMER BREAK has been great and the Plant Heroes (Aponi, Frankie, Laura and Nate) have been busy, but before starting the new school year they meet up for their annual camping trip reunion! After they pitch the tents, they start exploring the rest of the surrounding clearing and nearby forest...

Aponi discovers big clusters of honey-brown mushrooms growing and sprouting out of several old stumps.



Nate finds a few fallen trees nearby, some snapped near the base and others with roots pulled out of the ground.



Laura sees some trees around the edge of the clearing that are clearly dead but still standing.



Laura chips some bark off of one and, underneath, finds some freshly decayed wood that is unusually white. Curious, she uses her hatchet to chop out a few pieces and puts them in a plastic bag in her backpack.



Frankie is practicing his climbing skills on some trees just outside the clearing and notices that a few have some yellowing needles and dead tips.



**Over the campfire that evening...  
the Heroes trade stories about what each of them saw and where.**



Pretty quickly they see the pattern ... trees in the middle of the clearing have been dead the longest and that whatever killed them is **GROWING INTO THE FOREST!**

As they turn to look around, they notice the eerie glow coming from the top of Laura's backpack on the picnic table.



**THAT'S FOXFIRE!**

Nate explains to the others that he's heard lots of different kinds of fungi glow but that some of them are **REALLY BAD** for the forest and they need to try to find out what kind it is.

The next morning they take a closer look at some of the dead trees and, under the bark, find thick mats of dark stringy fibers. "UH-OH!" says Nate, "THAT LOOKS LIKE SHOESTRING ROOT ROT!"



The Heroes rush to the park headquarters and tell the local forester what they've seen. She runs some tests to be sure and then brings in excavators to remove all of the dead and dying trees. It's a mess, but at least they've stopped the fungus from spreading further into the woods!



After all the stumps are gone, the Heroes help restore the forest by replanting the area with trees that are resistant to the fungus.

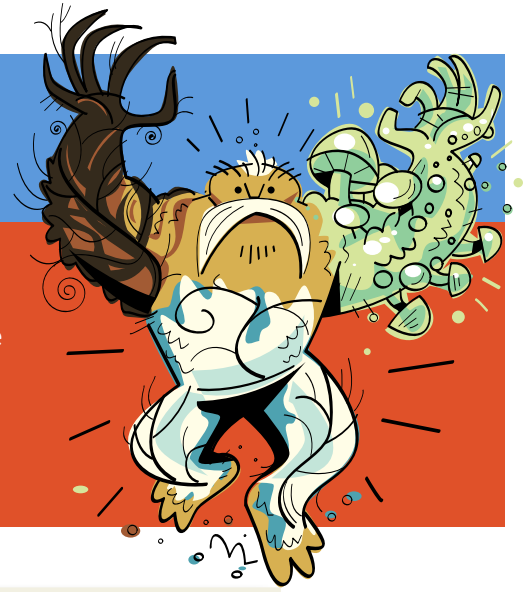


The Plant Heroes are brought to you by the American Public Gardens Association. This comic was developed with financial support from the USDA — Animal and Plant Health Inspection Service and reproduced with financial support from the USDA — Forest Service. Play games and learn how you can protect plants at [plantheroes.org](http://plantheroes.org).



# A Glowing Fungus

*Armillaria* “shoestring” root rot is a type of fungus that attacks the living tissue of the tree, cutting off the tree’s ability to transport water and nutrients to its leaves. *Armillaria* fungi are believed to be some of the oldest organisms on earth and are capable of surviving for thousands of years. The fungus can be well established before the tree starts to show any symptoms, and sometimes the only sign of infection is that the tree grows more slowly.



At night, the mycelium of this fungus gives off a dim blue-green light that is sometimes called “foxfire.” The ability of an organism to create light is called “bioluminescence,” and many different species of fungi can do this. Scientists think that fungi produce light to attract insects that can spread their spores. If you have the chance to go to the forest at night with an adult, see if you can spot the dim glow of bioluminescent fungi!

**HANDY TIP!**  
“Fungi” means more than one fungus; “fungus” means just one fungus.

## DID YOU KNOW?

Not all fungi are harmful. Some fungi assist plants to get nutrients from the soil and help plants grow!

A

B



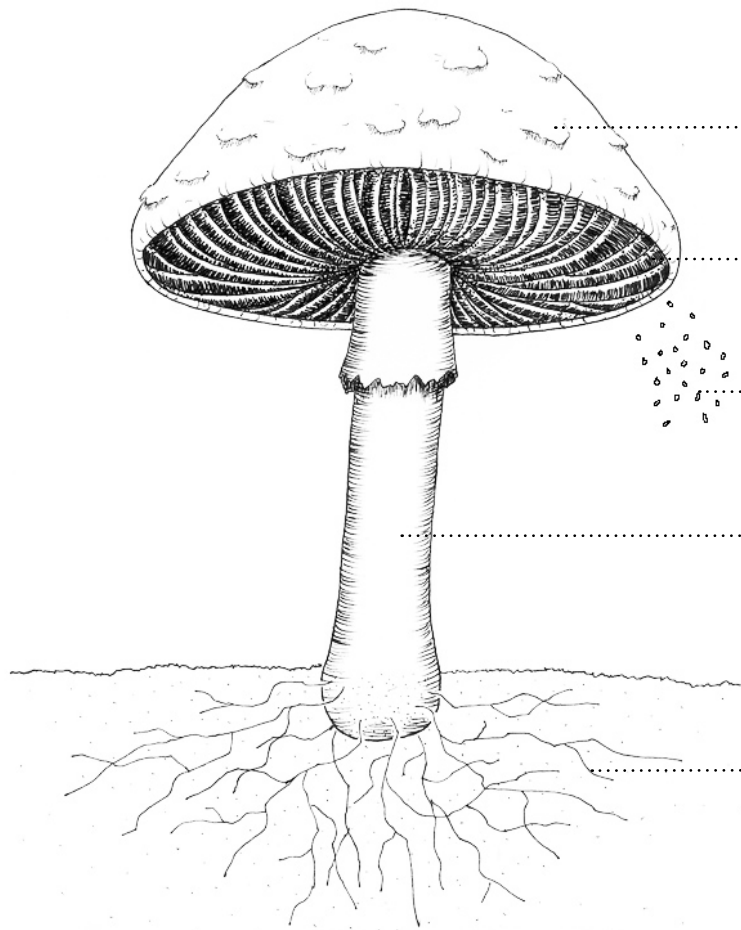
plantheroes.org

© 2021 American Public Gardens Association

PHOTO CREDITS: A: highlatitude, Flickr.com; B: Martin Livezey, mushroomobserver.org

# Parts of a Mushroom

Did you know mushrooms have gills? But these aren't like the gills of a fish! Learn more about the structure of a mushroom by matching each part to the correct description below.



**CAP**

**GILLS**

**SPORES**

**STALK**

**MYCELIUM**

1. \_\_\_\_\_ This part of the mushroom is shaped like an umbrella.
2. \_\_\_\_\_ These fanlike parts of a mushroom are named after a part of a fish.  
This is where the spores develop.
3. \_\_\_\_\_ This very light part of a mushroom can be carried by the wind to a new location  
to grow a new mushroom.
4. \_\_\_\_\_ This part of the mushroom holds up the rest of the mushroom.
5. \_\_\_\_\_ This root-like part of the mushroom is present even when the other parts are not present.



# Fungi Fun

A fungus is a living organism or being that is neither a plant nor an animal. Fungi are the great recyclers of the environment, taking their nutrition from organic matter (like a tree). Some common fungi that you might recognize include mushrooms and molds. Fungi come in all shapes and sizes and are sometimes named after what they look like. Can you guess what the following fungi are named after?



1. ....



2. ....



3. ....



4. ....

Look around in a park or garden near you. Can you find any fungi? They will probably be growing on rotting logs near the forest floor. Be sure not to touch or eat any fungi you find outside—some fungi are very poisonous!



# Meet the Trees!

*Armillaria* “shoestring” root rot can impact many different trees. These trees are called “hosts” because the fungi are the “guests” that feed on them. Below are some of the host trees of *Armillaria* “shoestring” root rot. Search in a garden or park near you and see if you can find any of the leaves of these host trees (check the hints below and your field guide host pages for help). Draw or describe what each leaf looks like.



## BITTERNUT HICKORY



*Carya cordiformis*

Hint: The leaves of this tree can be up to a foot long and have 7-9 leaflets with hairy undersides. This tree produces roundish green fruit.

## DOUGLAS FIR



*Pseudotsuga menziesii*

Hint: This tree produces fragrant, thin leaves called “needles” that are about an inch long.

## NORTHERN RED OAK



*Quercus rubra*

Hint: The leaves of this tree have 7-11 points called “lobes.” In the fall, this tree produces round acorns.



plantheroes.org

© 2021 American Public Gardens Association

PHOTO CREDITS: A: Virginia State Parks, Flickr.com; B: Roland Tanglao, Flickr.com; C: Chesapeake\_Bay Program, Flickr.com

# Underground Maze

*Armillaria* has three different structures that can be used to identify it. Learn more about the different parts of *Armillaria* “shoestring” root rot by completing the maze below.



## Honey-Colored Mushrooms

When conditions are right in late summer or fall, the fungus produces honey-colored mushrooms at the base of trees.



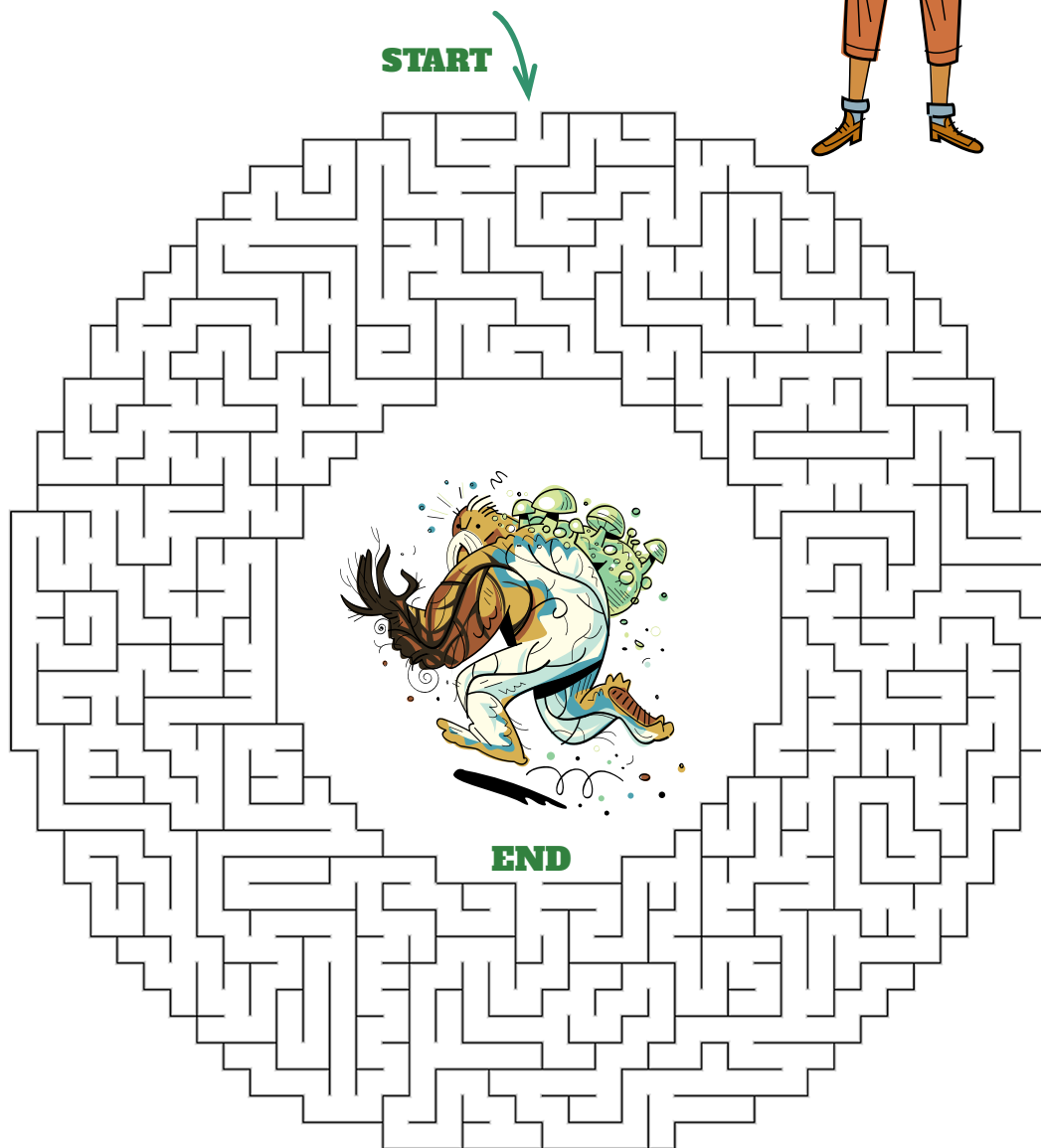
## Mycelium

This creamy-white, papery substance grows in a fan shape just beneath the bark and within the roots of infected trees. This part of the fungus grows and collects the nutrients it needs.



## Rhizomorphs

These stringy, spaghetti-like extensions give *Armillaria* its common name: “shoestring” root rot. They extend from the mycelium and form branched networks that grow in dead wood and through the soil.



Many fungi spread out from a central point, often creating a circle. In a forest, that can mean circles around trees that are dead or dying. When you find a mushroom, you are only seeing a small part of what can be a huge maze of root-like rhizomorphs that can spread across miles of forest. One Humongous Fungus, which was found in Oregon, covers 4 miles of forest and is believed to be between 2,400 and 8,650 years old.



[plantheroes.org](http://plantheroes.org)

© 2021 American Public Gardens Association

PHOTO CREDITS: A: R.Englesman, Flickr.com; B: William Jacobi, Bugwood.org; C: Kathi Hodge, Flickr.com

# Slow the Spread!

The Plant Heroes are *Armillaria* “shoestring” root rot experts, and they know all the right ways to stop the fungus from spreading. Fill in the blanks below to learn their tips and tricks.



## WORD BANK:

**WESTERN LARCH, STUMPS, THINNING,  
FOREST MANAGEMENT, SPREAD,  
FIREBREAKS, WESTERN RED CEDAR**

1. Once *Armillaria* “shoestring” root rot is at a location, it cannot be removed. However, \_\_\_\_\_ practices can slow its \_\_\_\_\_ and impact on forest health.
2. \_\_\_\_\_, (removing some trees) or creating \_\_\_\_\_ (a cleared path between trees) can make it more difficult for the fungus to spread from tree to tree.
3. Removing infected trees, \_\_\_\_\_, and roots can help reduce the damage and slow the spread.
4. Some trees, like \_\_\_\_\_ and \_\_\_\_\_, are less susceptible to the fungus. Planting more of these trees can help keep the forest healthy.

---

## ANSWER KEY

**Parts of a Mushroom:** 1. cap; 2. gills; 3. spores; 4. stalk; 5. mycelium

**Fungi Fun:** 1. coral, coral fungi; 2. turkey, turkey-tail fungi; 3. bird’s nest, bird’s nest fungi; 4. ear, wood ear fungi

**Slow the Spread!** 1. forest management, spread; 2. thinning, firebreaks; 3. stumps; 4. western larch, western red cedar





Join our team of Plant Heroes and learn about trees, forests, and the natural world around you!

**PLANTHEROES.ORG**

### You can be a Plant Hero!

Are you curious about plants and animals? Do you like asking questions about nature? Do you enjoy being outdoors and having fun, climbing trees, balancing on logs, or finding a new butterfly or beetle? If so, you are already on your way to becoming a Plant Hero! We invite you to join forces with Nate, Laura, Aponi, and Frankie to protect the plants and ecosystems we all love.

### How can you become a Plant Hero?

Join our team and go on a journey with Nate, Aponi, Laura, and Frankie. As a Plant Hero, you will learn to notice when plants are in trouble. You will also find out ways you can act quickly to help find solutions in your own neighborhood. Follow their adventures and learn how they help plants and ecosystems stay healthy.

**On the Plant Heroes website, you will find** materials to help you learn about plants, forest health, and ecosystem balance. The more you know, the more you can help protect plants and ecosystems in your own yard, neighborhood, and community!

**Plant Heroes strives to spark curiosity about nature and science in all children.** Our program provides hands-on, nature-based learning materials for educators to engage children in topics of plant health, ecosystem balance, and forest health. We also spotlight the amazing work our public gardens do in protecting the plants and ecosystems we all depend on through our website and printed materials. Visit [plantheroes.org](http://plantheroes.org) today to learn more!

**Plant Heroes is brought to you by the American Public Gardens Association**, founded in 1940. Over the last eight decades, the Association has supported the work of public gardens in North America and beyond. Our mission is to champion and advance public gardens as leaders, advocates, and innovators in the conservation and appreciation of plants. Our vision is "A world where public gardens are indispensable" as they provide botanic, conservation, community, education, and economic resources to their community.

The Association is committed to increasing the knowledge of public garden professionals throughout North America through information sharing, professional development, networking, public awareness, and research, so that they have the tools to effectively serve visitors and members.



**American  
Public Gardens  
Association**

[PublicGardens.org](http://PublicGardens.org)



This publication was developed with financial support from the US Forest Service and the USDA Animal and Plant Health Inspection Service.

