Arkansas Natural Heritage Commission

Educator's Guide

to discovering science, nature, art, social history, and public land conservation through

the Amazing Life and Works of

Beatrix Potter

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An Introduction to Beatrix Potter

This summer (July 28, 2016) marks the 150th anniversary of the birth of famed children's author Beatrix Potter. In addition to her beloved Peter Rabbit stories, Potter was a scientific illustrator and early land conservationist.

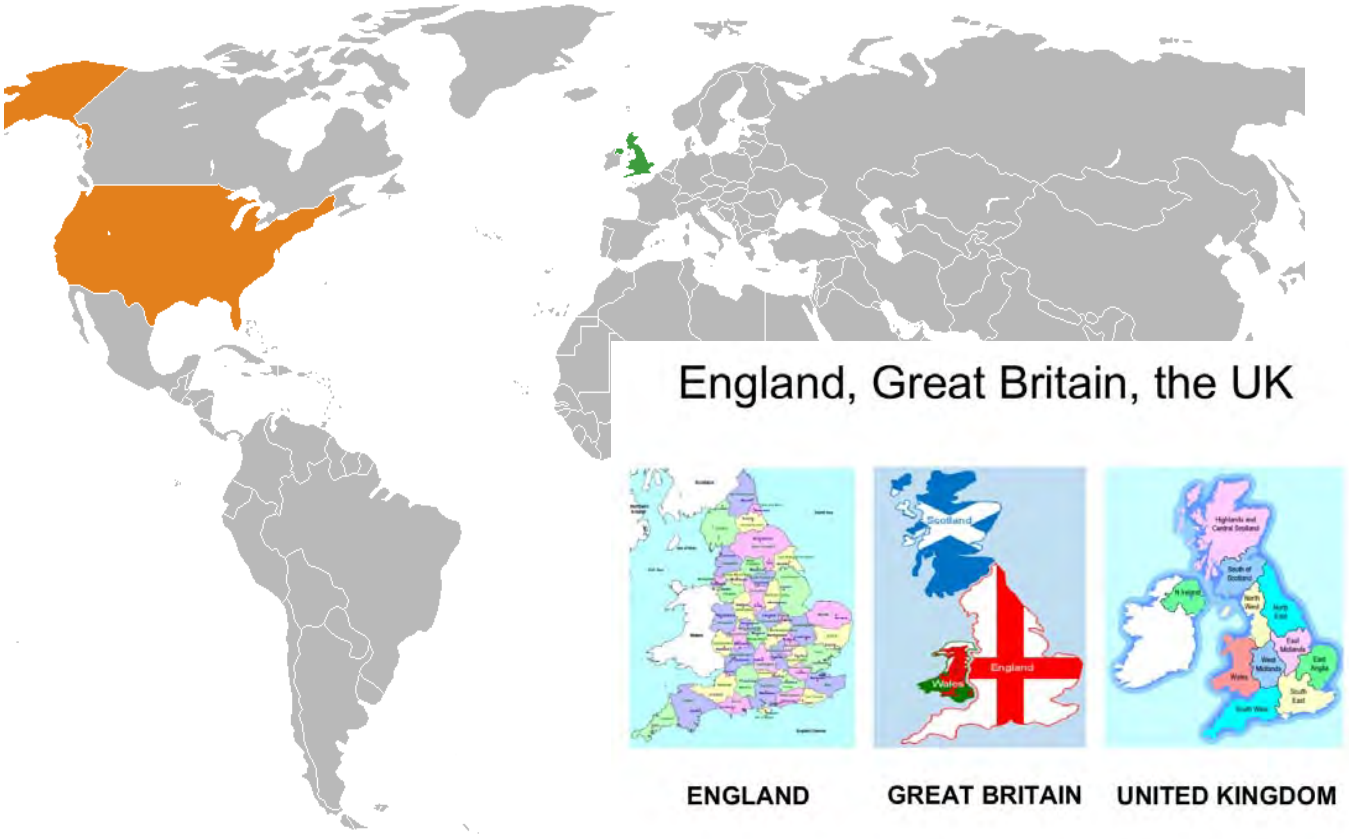
To highlight her sesquicentennial birthday and the additional excitement of a newly discovered manuscript to be released as a book this fall, the Arkansas Natural Heritage Commission (ANHC) has developed educational materials and programs that use the story of Potter's life to introduce facts about the mushrooms and lichens she illustrated, the struggles of women to be recognized in science and publishing, links to art and nature, and the importance of safeguarding public lands.

The following information is provided as a supplement to these programs.

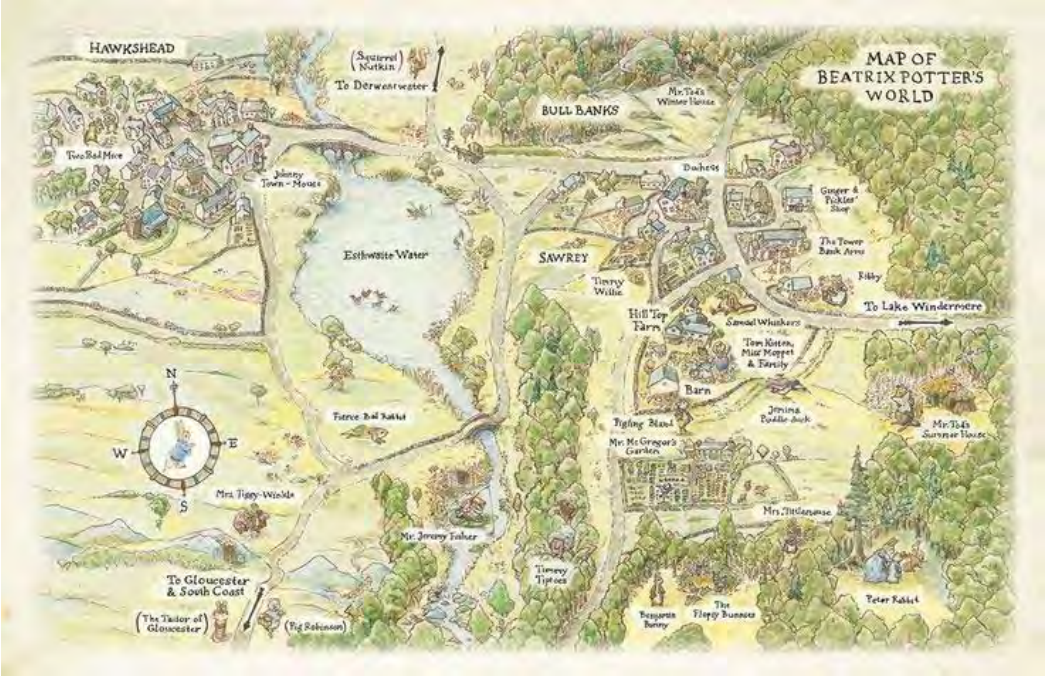
GENERAL CONCEPTS

Place

Helen Beatrix Potter was born in London, England on July 28, 1866, and spent her entire life in the United Kingdom. Her stories also take place there. Students should have an understanding of where the island of **Great Britain** is located, both in relation to the world and to Arkansas and the **United States**. Older students may appreciate the differences between the United Kingdom (or U.K.) the country, Great Britain, the island, and England, one of the U.K.'s four administrative regions.



The map at the right illustrates the farms and lands that Beatrix Potter eventually acquired with the earnings from her children's books. She lived at Hilltop Farm and Castle Cottage until her death in 1943. She rescued several areas from development and left over 4,000 acres to the UK National Trust.



Public Lands

Public lands are lands that belong to a unit of government and are managed for the benefit of all citizens of that government. Students may not understand that many pieces of land or property in their community "belong" to offices or entities of local government, including the land of their school, favorite park, or athletic field. In some cases, governments use public tax funds to buy land, but in other situations, people donate their land to a particular government agency.

People, such as Beatrix Potter, who want to make sure their land is not destroyed, developed or changed sometimes choose to donate their property to a government to protect it. Ms. Potter chose the National Trust in Great Britain. In Arkansas, the Arkansas Natural Heritage Commission (ANHC) has the responsibility to protect areas of land in their natural state and over the years, people have chosen to donate their land to the ANHC to be sure that it is protected.

One of those areas is H. E. Flanagan Prairie Natural Area in Franklin County, near Fort Smith. This property was donated by the late Senator Dale Bumpers' wife Betty's family.

See more about this property at:

http://www.naturalheritage.com/natural-areas/h-e-flanagan-prairie-natural-area

Time

Beatrix Potter was born July 28, 1866, which makes the year 2016 the sesquicentennial anniversary of her birth (see vocabulary words). She lived from 1866 to 1943 and spent the first half of her life in what is referred to as the Victorian era or period. Victorian times means during Queen Victoria's rule—the time Queen Victoria was on the throne. An in-depth study of British history is not necessary, but students should have a general understanding that during the early part of Ms. Potter's life, there was no electricity. Instead gas lamps or candles were used for light. There were no cars, instead people traveled by horse, carriage or train. And women were generally seen as inferior to men.

The role of women in Britain during the late 19th and early 20th centuries directly impacted Ms. Potter's life. The timeline below will help students with a general understanding of how women's rights progressed through her lifetime.

1865 Elizabeth Garrett Anderson becomes the first British woman doctor.

1869 Women are allowed to vote in local elections.

1880 In Britain three women are awarded degrees by the University of London. They are the first women to be awarded degrees by a British university.

1892 Isabella Bird becomes the first woman member of the Royal Geographical Society.

1895 Lilian Lindsay becomes the first woman in Britain to qualify as a dentist.

1898 Ethel Charles becomes the first woman in Britain to qualify as an architect.

1908 Aldeburgh becomes the first town in Britain to have a female mayor.

1914 Britain gets its first policewomen.

1917 In Britain, The Women's Royal Naval Service is formed.

1918 In Britain, women over 30 are allowed to vote.

1919 In Britain, the Sex Disqualification Act allows women to become lawyers, vets and civil servants. The Women's Engineering Society is formed.

1928 In Britain, all women over 21 are allowed to vote the same as men.

1946 Lilian Lindsay becomes the first woman president of the British Dental Association.

1956 Rose Heilbron becomes the first woman judge in Britain.

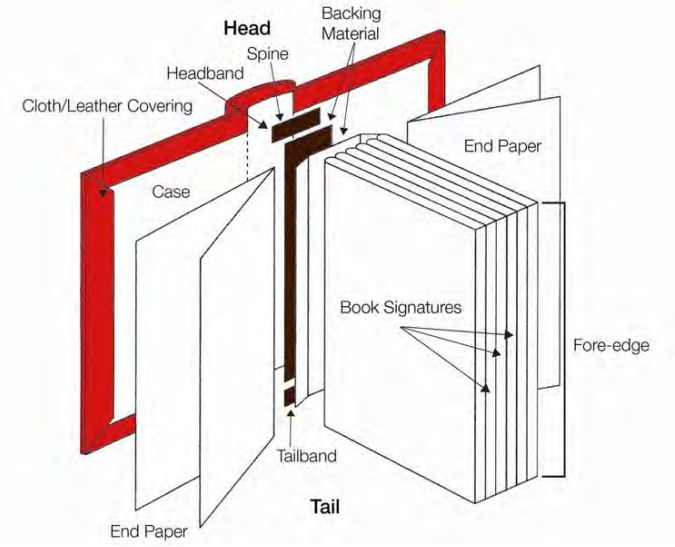
1958 Hilda Harding becomes the first woman bank manager in Britain.

1970 An Equal Pay Act is passed in Britain.

1973 In Britain women are allowed to join the stock exchange for the first time.

1975 The Sex Discrimination Act makes it illegal to discriminate against women in employment, education and training.

Publishing



Beatrix Potter struggled to get her first books published and later relied on the sale of her books to support herself as a single woman. In these days of laser printers and photocopiers, students may need help appreciating that her first book was printed with a process using woodblock engravings of each page. They should also be encouraged to look at a hardback book and think about the different parts that must be printed and then assembled to make a book (see illustration).

Money (and math)

Beatrix Potter's first book, The Tale of Peter Rabbit, was originally published in 1902 and cost one shilling. Students should first understand the general idea that different counties have different types of money or currency and each of these have different values.

In this country, we use the U.S. or American dollar ($).

Great Britain currently uses pound sterling or simply "the pound" (£)which is divided into 100 pence (singular penny).

Refer to the chart at right for samples of coins.

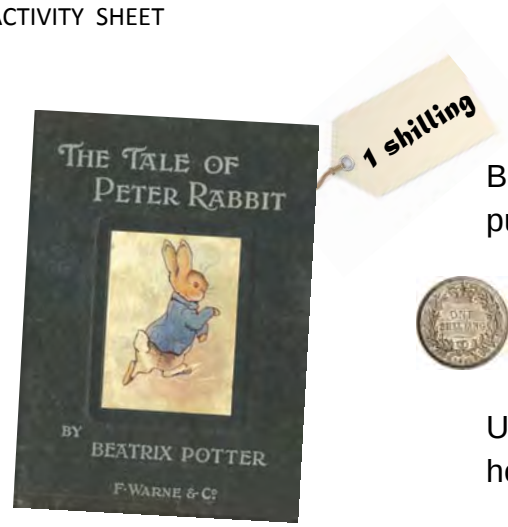
Today, £1 in the UK is equal $1.40 in the U.S. This means that to purchase something that costs a £1 in the UK, you would pay $1.40 in U.S. money. In 1902, when Ms. Potter's first book was for sale, £1was equal to $4.87.

Today, the currency of all the UK is based on a decimal system of one basic unit of currency with sub-units that are a power of 10 of the base. This type of system has only been in place in the UK since 1971.

Under the old currency of pounds, shillings and pence, the pound was made up of 240 pence, 12 pence were in a shilling, and 20 shillings were in a pound.

On the following page, a student work sheet applies these monetary conversations to the price of The Tale of Peter Rabbit.

How much did Peter Rabbit cost?



Beatrix Potter's first book, The Tale of Peter Rabbit, was published for sale in 1902 and cost one shilling.

This is a one shilling coin, but if you did not have this coin, you might have used other denominations of money, such as a pence or one pound.

Use the information below to answer the questions about how you might have paid for the book.

1 shilling equals 12 pence

1 pound equals 20 shillings

1. If you had 12 pence, could you buy the book? _____ Explain your thinking

   _____

2. If you had 20 pence and wanted to buy the book,

   would you have any change left?_____ if yes, how much? _____ Explain your thinking _____

3. How many copies of the book could you buy with 1 pound? _____ Explain your thinking _____

4. If you paid for one book with a 1 pound note, how much change would you get? _____

   Explain your thinking _____

5. In 1902, one pound (£ 1) was equal to four dollars and eighty-seven cents ($4.87), in U.S. dollars. How much would the book have cost, using U.S. money? _____

   Explain your thinking _____

Beatrix Potter the mycologist and scientific illustrator

Educated privately through governesses at home, Beatrix's talent in drawing was recognized early and further tuition in painting was provided. However, Beatrix did not wish to copy other painters but experiment with her own style, later sticking with watercolors. Beatrix cared for a lot of pets at home and these provided a great source of inspiration for many of her drawings. She also drew a menagerie of animals secretly hidden in the nursery with her younger brother Walter Bertram including mice, rabbits, bats, snails, egg collections and insects.

At first, Beatrix observed the organisms using a hand lens. Then she used a camera and finally her younger brother's microscope. The use of the microscope led to her fascination with fungi. The color and structure of the mushrooms caught her interest first, but in her 30s, Beatrix became interested in the role of spores in the reproduction of different mushrooms. At the time this topic was highly debated within British mycologist circles.

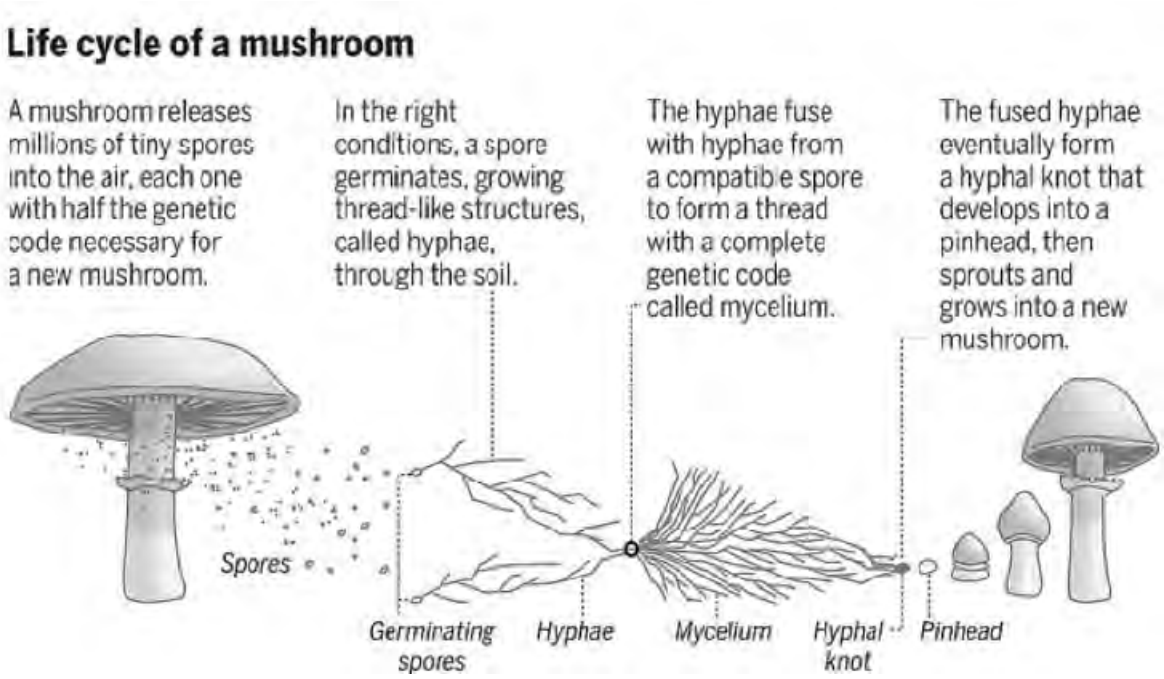
On a holiday to Scotland in 1892, Beatrix formed an alliance with a noted naturalist Charles McIntosh. She exchanged her accurate drawings of rare specimens for his knowledge of mushroom life cycles and taxonomy. By 1895, Beatrix had collected and drawn the spores and spore-producing structures (basidia) of the mushroom *Boletus granulatus*, now called *Suillus granulatus*. She had also successfully managed to germinate spores of a number of species and produced drawings of the mycelium.

With these interesting results, Beatrix approached the Royal Botanic Gardens at Kew Gardens only to be dismissed by the current director, Willian Thiselton-Dyer. However, her uncle, the chemist Henry Enfield Roscoe, encouraged Beatrix to continue her research into fungal spore reproduction. She then later offered to the Linnean Society in London, even though at the time they did not admit women to the society or even allow them to attend meetings. The paper Beatrix submitted was titled 'On the germination of the spores of Agaricineae' (illustration at right) and contained many of her microscope drawings. This paper has since been lost but it seemed as if Beatrix was heavily interested in the idea of hybridization.

After a lifetime of drawing, Beatrix donated her botanical and mycological drawings to the Armitt Museum and Library in Ambleside, Lake District. These are still used today by both amateur and professional mycologists. Fifty-nine of her drawings were reproduced in a book on fungi.

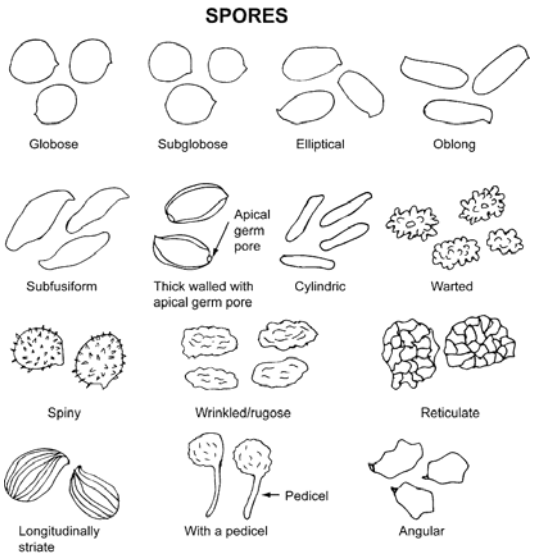
Why are spores important to mushrooms?

Spores are the "seed" or the part of the mushroom that allows it to reproduce or grow new mushrooms and spread.



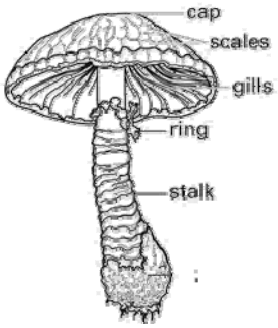
What parts of the mushroom did Beatrix Potter observe and draw?

Beatrix first began drawing whole mushroom but quickly became interested in how they developed. She used a microscope to see and draw the tiny spores. She was also able to grow or germinate spores into hyphae and mycelium, and finally into new mushrooms.



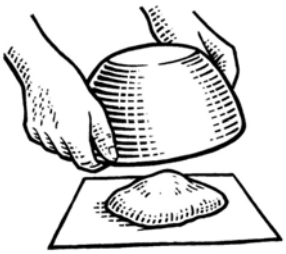
How to make a mushroom spore print

Select a mushroom with gills that is mature, with no signs of decay. The spores lie on the gill surface.



Cut off the stem and place the cap, with the gills facing down, on a piece of aluminum foil, a white piece of paper, an index card or a glass microscope slide.

Put a drop of water on the top of the cap to help release the spores.



Cover the cap with a paper cup or glass and leave for 2-24 hours, depending on the humidity and the freshness of the mushroom.

The spores will fall on the paper, foil or glass, making a spore print pattern.

Spore prints can be preserved on paper or foil by spraying them lightly with an artist spray. Hair spray works well, too. Caution: Hold the spray at least 12 to 15 inches above the print or you may blast the spores right off the paper!

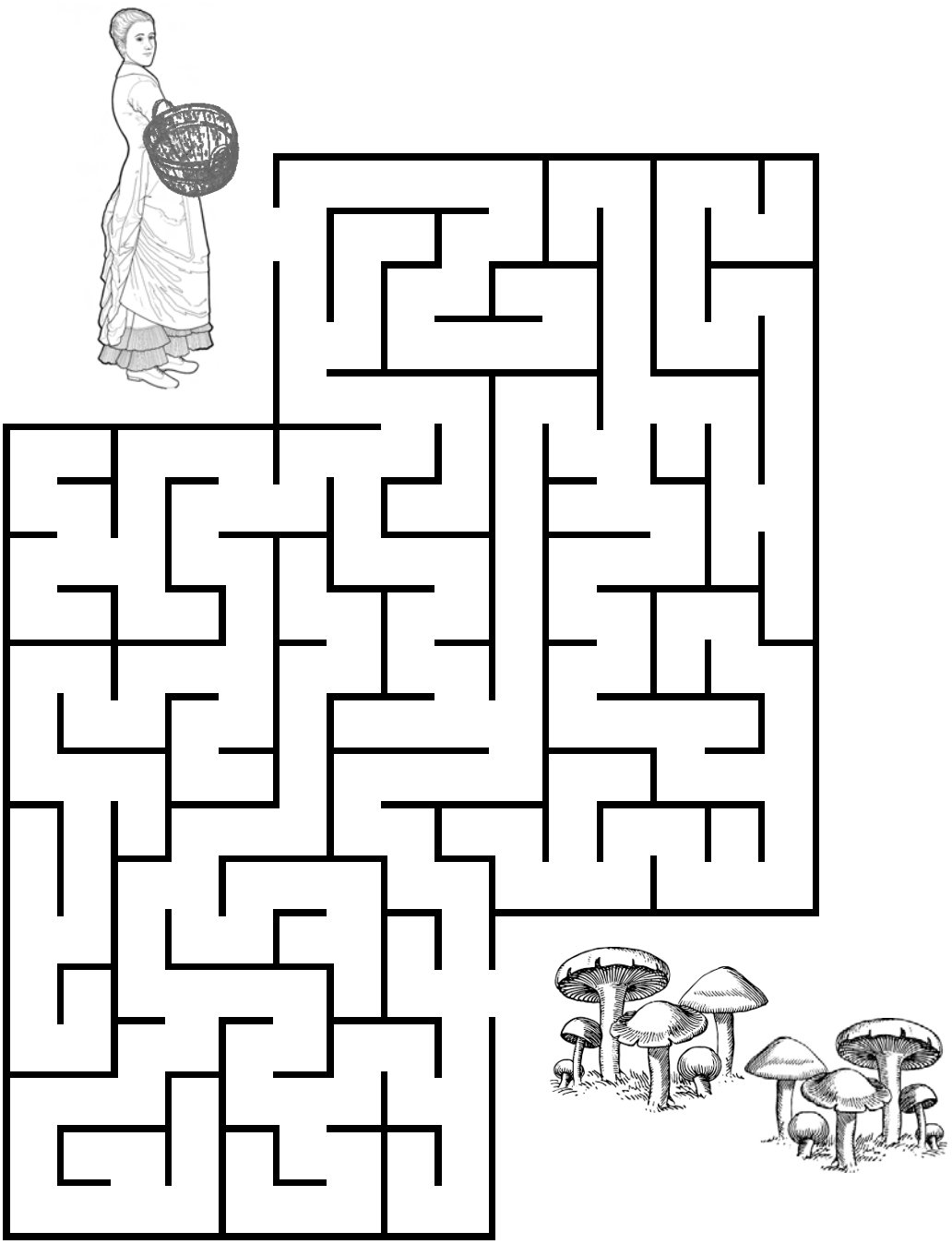
To study the spores with a microscope, scrape off some of the spores from your spore print with a needle or scalpel, and place the spores on a microscope slide. Place a drop of water on the spores and cover with a cover slip.

Caution: mushrooms are easily available from supermarkets year-round, but you can also use mushrooms that you collect from the wild. If handling wild mushrooms, make sure students understand that they are NOT edible and, in some cases, can be dangerous if consumed. Also check to see that no students have mushroom allergies before beginning a spore print project.

Mushroom Maze

Beatrix Potter studied and painted mushrooms. She gathered them in forests and fields near her home.

Can you help her find her way through the maze below to the mushrooms?



Around the age of 15, Beatrix Potter began a journal written in a secret code that she invented. She did not write in the journal every day but did keep making regular entries until she was 31 years old. She stopped writing her coded journal about the time she began working to publish her children's books.

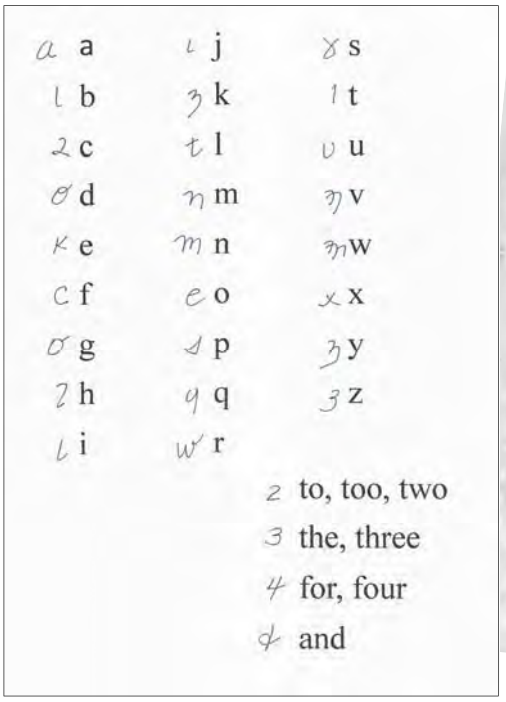
She did not tell anyone about the journal and it was not discovered until several years after her death.

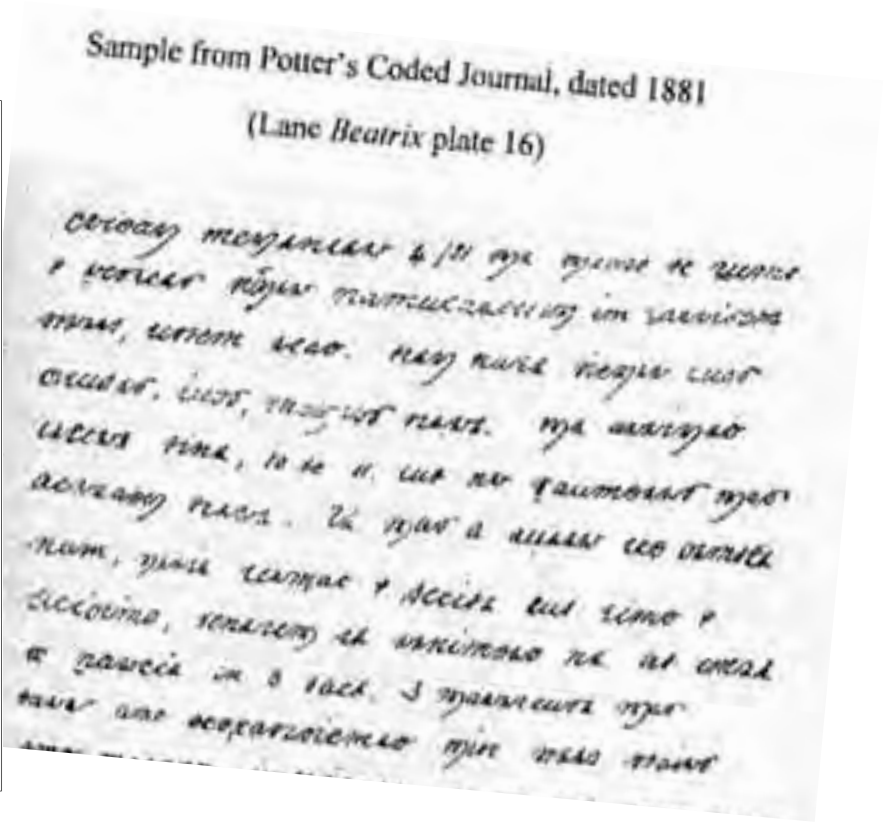
The code was cracked by an engineer named Leslie Linder who collected Beatrix Potter drawings. He was able to break her code in 1958 and spent five years decoding all he entries. He later published her entire journal in 1966.

Below is alphabet Beatrix Potter invented, as Linder decoded it, along with a sample writing from her journal. She underlined letters to indicate capitals and often combined symbols such as "4get" or "2gether,"similar to the contractions we use today in texting. She also wrote in very small handwriting and used several different notebooks and even scraps of paper over the 15 years that she kept the journal.

SIMILAR WORDS FOR DISCUSSION

Some students may wonder why these writings are called a ***journal*** and not a ***diary***. The two words mean essentially the same, although journals tend to cover longer periods of time between entries. Also, in today's world, the word ***code*** is often used to mean instructions to a computer, such as a person who learns to "write code." For Beatrix Potter's journal, the word ***code*** is used to mean "a system of symbols used to represent assigned and often secret meanings."





Beatrix Potter made up her own secret code to write in her journal. She used a combination of letters and symbols to represent the letters in the alphabet. Many years later a man who loved her books and pictures found her journal and figured out her code by first discovering the symbol for one letter.

Below are two sentences written in a similar code. You have been given two letters, "E" and "T" to help you discover the rest. All of the words are written with capital letters, so you will not know which ones might be a name but there are periods at the end of the sentences. As you decode the sentences, it may help to write each symbol below the letter in represents. Good Luck!

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
				I															Θ						

E T T T E T E

N I Λ Θ Σ P Z K X Θ Θ I Σ Ψ Σ X Θ I O Λ M H

T E T T E

ς Θ X Σ P I ς Λ N X Ω Θ Λ M P O Λ Γ ς Θ Y I

T E T E T

∂ P Σ ς Θ N X X Φ ς Y I Ψ Σ X Θ I Ψ Λ ς Λ N X Ω Θ

T .

Λ Σ Λ N N P Θ

algae - either single-celled or large, multicellular organisms. They can occur in freshwater or salt water (most seaweeds are algae) or on the surfaces of moist soil or rocks. The multicellular algae lack the true stems, leaves, or roots of the more complex, higher plants, although some—like the giant kelp—have tissues that may be organized into structures that serve particular functions. The cell walls of algae are generally made of cellulose and can also contain pectin, which gives algae its slimy feel.

author - a person who creates a written work

currency - a system of money in general use in a particular country

fungus - any of a kingdom of living things (as molds, rusts, mildews, smuts, and mushrooms) that lack chlorophyll, are parasitic or live on dead or decaying organic matter, and were formerly considered plants

governess - a woman who teaches and trains a child in a private home

illustrator - someone who provides pictures or diagrams intended to explain or decorate, such as to illustrate a book

lichen - any of numerous plantlike living things made up of an alga and a fungus growing together on a solid surface (as a rock or a tree)

mushroom - a fleshy part of a fungus that bears spores, grows above ground, and consists usually of a stem bearing a flattened cap

mycology - the branch of biology dealing with fungi

publish - to produce or release for publication; especially to print written work

sesquicentennial - term broken down as sesqui- (one and a half) centennial (100 years); An anniversary day that commemorates or celebrates a past event that occurred on the same date of the year as the initial event 150 years ago.

shilling - a former unit of British money equal to 1/20 pound; In the traditional pounds, shillings and pence system, there were 20 shillings per pound and 12 pence per shilling, and thus there were 240 pence in a pound. (current exchange rate: 1 British Pound equals 1.40 US Dollar)

spore - a small, usually single-celled reproductive body that is resistant to adverse environmental conditions and is capable of growing into a new organism, produced especially by certain fungi, algae, protozoans, and non-seedbearing plants such as mosses and ferns.

Complete List of Books by Beatrix Potter

The Original 23 "Tales" Books

The Tale of Peter Rabbit (1902)
The Tale of Squirrel Nutkin (1903)
The Tailor of Gloucester (1903)
The Tale of Benjamin Bunny (1904)
The Tale of Two Bad Mice (1904)
The Tale of Mrs. Tiggy-Winkle (1905)
The Tale of the Pie and the Patty-Pan (1905)
The Tale of Mr. Jeremy Fisher (1906)
The Story of A Fierce Bad Rabbit (1906)
The Story of Miss Moppet (1906)
The Tale of Tom Kitten (1907)
The Tale of Jemima Puddle-Duck (1908)
The Tale of Samuel Whiskers (1908)
The Tale of the Flopsy Bunnies (1909)
The Tale of Ginger and Pickles (1909)
The Tale of Mrs. Tittlemouse (1910)
The Tale of Timmy Tiptoes (1911)
The Tale of Mr. Tod (1912)
The Tale of Pigling Bland (1913)
Appley Dapply's Nursery Rhymes (1917)
The Tale of Johnny Town-Mouse (1918)
Cecily Parsley's Nursery Rhymes (1922)
The Tale of Little Pig Robinson (1930)

Other Books

Peter Rabbit's Painting Book (1911)
Tom Kitten's Painting Book (1917)
Jemima Puddle-Duck's Painting Book (1925)
Peter Rabbit's Almanac for 1929 (1928)
The Fairy Caravan (1929)
Sister Anne (illustrated by Katharine Sturges) (1932)
Wag-by-Wall (decorations by J. J. Lankes) (1944)
The Tale of the Faithful Dove (illustrated by Marie Angel) (1955, 1970)
The Sly Old Cat (written 1906; first published 1971)
The Tale of Tuppenny (illustrated by Marie Angel) (1973)
The Tale of Kitty-in-Boots (original manuscript from 1914, rediscovered in 2015)(illustrations by Quentin Blake) (2016)

Books About the Life and Works of Beatrix Potter

Letters to Children from Beatrix Potter by Judy Taylor

A History of the Writings of Beatrix Potter: Including Unpublished Work by Beatrix Potter (Author), Leslie Linder (Editor)

Beatrix Potter: Her Inner World by Andrew Norman

Beatrix Potter: A Life in Nature by Linda Lear

Beatrix Potter: The extraordinary life of a Victorian genius by Linda Lear

The Journal of Beatrix Potter from 1881 to 1897 by Beatrix Potter (Author), Leslie Linder (Editor)

For Younger Readers

Beatrix Potter by Alexandra Wallner (used in ANHC Power Point program)

Who Was Beatrix Potter? by Sarah Fabiny (Author), Mike Lacey (Illustrator), Nancy Harrison (Illustrator)

Beatrix Potter and Her Paint Box by David McPhail (Author, Illustrator)

My Dear Noel: The Story of a Letter From Beatrix Potter by Jane Johnson (Author, Illustrator)

Beatrix Potter: The Story of the Creator of Peter Rabbit by Elizabeth Buchan

The Country Artist: A Story about Beatrix Potter by David Collins

Beatrix Potter by Charlotte Guillain

Websites

The Beatrix Potter Society in the UK
http://beatrixpottersociety.org.uk/

Website of Linda Lear, Beatrix Potter author and researcher—a variety of information, images, a time line, and summary of all Potter's books.
http://www.bpotter.com/

Peter Rabbit .com—the most up-to-date information about plans for the 150th birthday celebration of Beatrix Potter
http://www.peterrabbit.com/

Wired for Books—many Beatrix Potter stories in a variety of languages, in both text and audio
http://www.wiredforbooks.org/kids.htm

Life Cycle of a Mushroom and other interactives for lower primary grades

http://www.childrensuniversity.manchester.ac.uk/interactives/science/microorganisms/mushroomlifecycle/

DVDs

The World of Peter Rabbit and Friends, a TV series based on her stories, has been released on video and DVD Carlton Video and BBC Home Entertainment

Miss Potter, a movie of Potter's life focusing on her early career and romance with her editor Norman Warne. Renée Zellweger and Ewan McGregor play the lead roles – available in DVD and through a variety of on-demand services.

Correlations to Arkansas Department of Education Curriculum Frameworks

Science

The information on mushrooms can be correlated to the Life Sciences sections of both the Arkansas Department of Education Science Frameworks (revised 2005) and the Next Generation Science Standards (NGSS) that are being phased in over 2016 and 2017. Examples of NGSS Topics and Disciplinary Core Ideas include:

Mushroom life cycles	Inheritance and Variation of Traits: Life Cycles and Traits LS1-1 – Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death. LS1.B: Growth and development of organism
Mushroom structure	Structure, Function, and Information Processing LS1-1 – Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. LS1.A: Structure and Function
Mushrooms as decomposers	Matter and Energy in Organisms and Ecosystems LS2-1 – Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. LS2.A: Interdependent Relationships in Ecosystems
Mushroom mycelium uses in Technology (see page 18)	Engineering, Technology, and Applications of Science ETS1-2 - Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. Crosscutting Concepts: Influence of Science, Engineering, and Technology on Society and the Natural World Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands.

Mathematics

The word problems related to money on pages 4 and 5 correlate with Operations and Algebraic Thinking of the Common Core State Standards, Mathematic Standards, specifically:

CCSS.Math.Content.4.OA.A.3

Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.

English Language Arts

The stdy of Beatrix Potter's life correlates with the Common Core State Standards Connections, English Language Arts Standards » Speaking & Listening » Grade 5 » 3.

The books in the Resource Section (page 14) can for the basis for activities in Comprehension and Collaboration, including:

CCSS.ELA-Literacy

SL 1) Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners, building on others' ideas and expressing their own clearly.

SL 1.a) Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.

SL 1.b) Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).

SL 1.c) Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.

SL 1.d) Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.

SL 2) Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

The Beatrix Potter classroom program from ANHC education staff specifically correlates to:

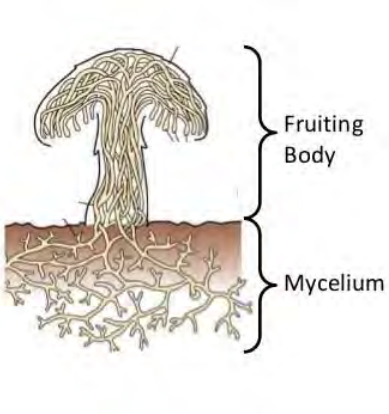
SL. 3) Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.

Fine Arts

Visual Arts K-8 (Revised 2014)
Strand: Responding
Content Standard 7: Students will perceive and analyze artistic work

Mushrooms and Modern Technology

The leader in promoting mushrooms and mycelia in today's technology is mycologist Paul Stamets. He has published many articles and books about mushrooms. His latest and most comprehensive is Mycelium Running: How Mushrooms Can Help Save the World (2005, ISBN 1-58008-579-2). An internet search will provide many of his resources, including his TED talk (https://www.ted.com/speakers/paul_stamets). Below is a summary of his talking points:



To understand why mushrooms are so crucial to Earth's ecosystems, we need to start with their lifestyle. Fungi are nature's decomposers. They spend most of their time unseen and underground, digesting the tissues of dead plants and animals molecule by molecule. If you've ever seen pearly white, cobweb-like material covering a log, you've witnessed a fungal feasting frenzy. As mycelia chew through the soil, they use their microscopic slenderness to unlock nutrients that plant roots can't access. They also sense their environment and relay a constant stream of information throughout their network, which the fungus uses to direct its growth.

In this manner, fungal mycelium can snake across a landscape – moving up to several inches a day, with no prescribed body plan – more or less indefinitely. (One of the largest organism on Earth is a 2.4-mile-across fungus in eastern Oregon.) They require only water, nutrients, and a steady supply of carbon to keep building forward. Saprotrophic fungi mine their carbon from the soil, by breaking down sugary cellulose and tough, woody lignin. Mycorrhizal fungi barter with plants, trading nutrients for sugar by bonding their mycelium with root systems. Most trees and other plants would never reach maturity if their fungal partners weren't supplying them with nitrogen and other critical nutrients.

For decomposers, no two lunches are ever the same. That's why fungi have evolved a variety of enzymes, which can be expressed in different situations. A fungus worming its way through a log will secrete mostly wood-digesting enzymes, while a mushroom chowing down on a dead beetle releases a mixture of enzymes that break down protein, carbohydrates, and chitin (the molecular building block of insect exoskeletons). To access as much of planet's organic energy as possible, fungi have gotten really, really good at breaking down just about everything. And that's exactly why we can use mushrooms to clean up the planet.

In 2011, a group of Yale undergrads on a field expedition to the Ecuadorian Amazon stumbled upon something extraordinary: *Pestalotiopsis microspora*, a rainforest fungus with a healthy appetite for polyurethane, the plastic found in everything from garden hoses to shoes to car seats. Once polyurethane enters landfills, it sits there for generations. How different would our waste disposal methods be if plastic could be eaten away in a few years?

The discovery of Pestalotiopsis is not an isolated case. Scattered across the world, mycologists have identified mushrooms that can replace their usual woody diet with more exotic snacks like petroleum. There are fungi that can soak up toxic heavy metals – including lead, arsenic and mercury – with no apparent side effects. There are even mushrooms that will feast on radioactive waste.

All of this goes back to fungal ecology. Mushrooms evolved to fill a very specific ecological role – that of our planet's digestive system. Now, some scientists want to use fungal digestion to our advantage, and train mushrooms to clean up our environmental messes. Stamets is involved with numerous such "mycoremeditation" efforts, including one that's using mushrooms to clean up the Deepwater Horizon spill, and another that's investigating whether radiation-loving fungi can help remediate Fukushima.

The notion that we can use fungus to mop up our nastiest environmental messes is exciting, but every day, we continue to build our world up with materials that pollute and don't degrade. What if we could begin phasing out environmentally destructive plastics, foams, and synthetic building materials? With fungi at our side, this might actually be possible. Mycelia — incredibly resilient and naturally biodegradable as it is — may, quite literally, build our future.

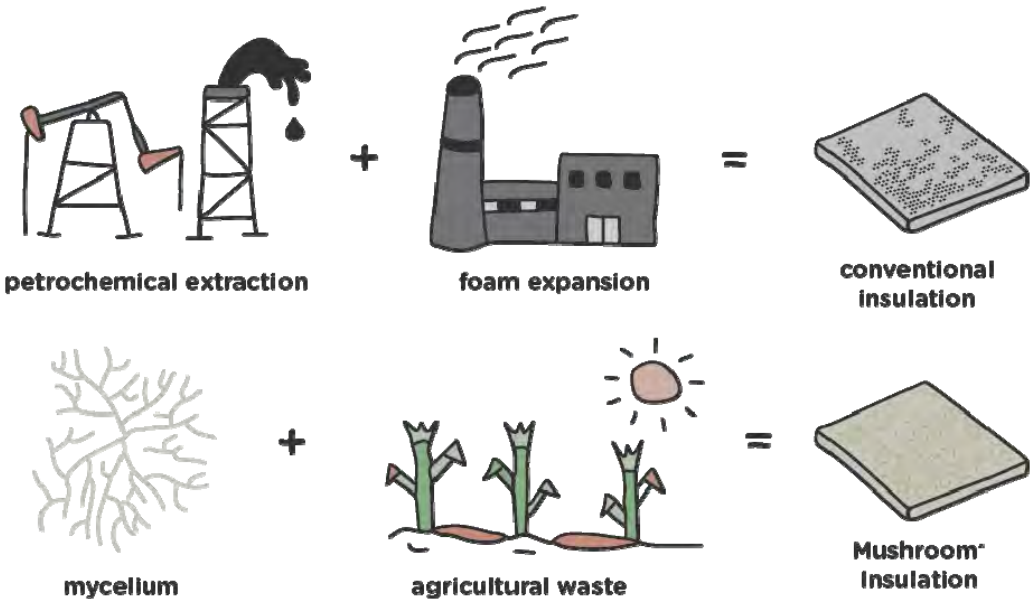
Building the Future

Another team of successful mycologists, Phil Ross, Eddie Pavlu, and Sophia Want, believe that mushroom bricks are one of the toughest materials on the planet. They discovered that, given the proper substrate and growth conditions, fungal mycelia can be assembled into nearly any shape and density. They used this knowledge to develop their MycoWorks business in 2013. Their early work involved filling a mold with sawdust and inoculating it with mycelia to form chairs and tables. But when they started growing interlocking bricks and building entire structures from mushroom mycelia, they realized they had stumbled onto something big.

The bricks can withstand incredible compression and shear forces. If two of them were put together in contact while the mycelium is still alive, they fuse together and the bond between them tends to be as strong as the brick itself.

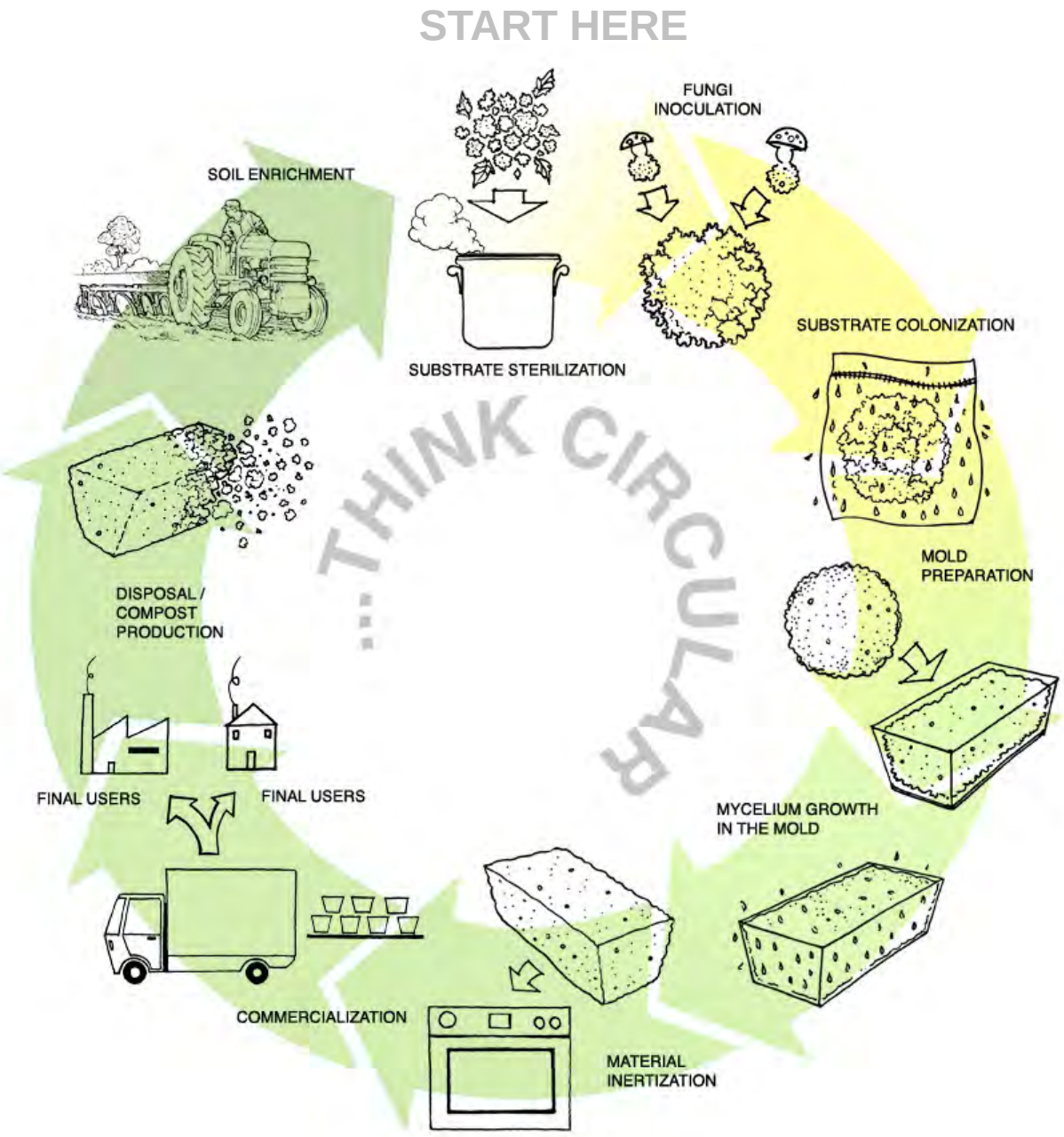
MycoWorks is now working to turn this into a scalable industrial product. Through partnerships with private industry, government and academia, the team is developing and refining mycelium-based materials that may one day ship our computers and line our buildings.

Many man-made building materials, include synthetic wood fiberboard and foam, are manufactured using toxic chemicals. Throughout their lifetime, fiberboards and plastics emit small levels of volatile organic compounds (VOCs), a class of pollutants which are associated with cancer and other health risks. Mycelium-based materials create no toxic byproducts and emit no VOCs.



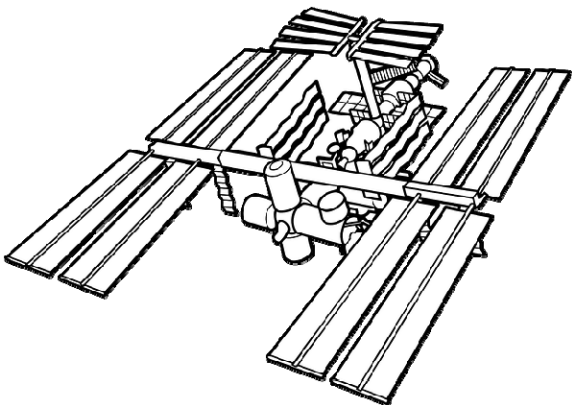
All it takes to grow this incredible material are agricultural waste products for which we literally have no other use. Examples include many forms of plant "waste" such as pistachio hulls, rice hulls, corn husk, and the millions of pounds of waste now exiting biofuel plants every year. MycoWorks has recently partnered with a large ethanol manufacturer to determine whether secondary biowaste —the plant material left over after the ethanol conversion process—can be a viable source of feedstock for mushroom bricks. To the MycoWorks team, the uses for mycelium are practically endless—houses, batteries, cars, spaceships. The biggest hurdle to the widespread adoption of fungal materials may, in fact, be us. Could we accept mushroom-based packing materials in place of Styrofoam?

The MycoWorks website (http://www.mycoworks.com/) includes a good video showing their entire work process, as well as images of their products.



One Final Note: Fungi in Space

In a series of studies recently published in the *International Journal of Astrobiology*, researchers tested the ability of different life forms to withstand space exposure by strapping them to the outside of the International Space Station. After 22 months awash in DNA-shattering UV radiation, with no food or water, spores of the fungi Aspergillus and Trichoderma remained alive.



Herdwick Sheep

The name "Herdwick" is derived from the Old Norse "herdvyck", meaning sheep pasture, and their place in the Lake District of England dates back to the 12th Century.

Beatrix Potter won a number of prizes for her Herdwick sheep at local shows, and became the first elected female President of the Herdwick Sheep Breeders' Association in 1943, a sign of the high regard in which she was held by the local farming community. She left her fifteen farms, covering over 4,000 acres, to the National Trust, and according to her wishes all continue to graze Herdwick flocks.

Herdwicks are a dual-purpose breed, producing strongly flavoured lamb and mutton and a coarse, grey wool. This slowly maturing breed is one of the most hardy of all the British hill sheep breeds, withstanding the cold and relentless rain of the Lake District at heights upwards of 3,000 feet.

Most Herdwicks spend winter on the fells, from approximately December to April. They are normally left to graze freely on the hillsides (without any additional feed), but each ewe tends to stay in her heaf (the local term for heft), the same small area of fell. The lambs graze with their mothers on the "heaf" belonging to that farm, instilling a life-long knowledge of where on the fell they should be grazing. This ability to thrive unassisted is part of the reason fell farmers so highly value Herdwicks over much higher-producing lowland breeds.

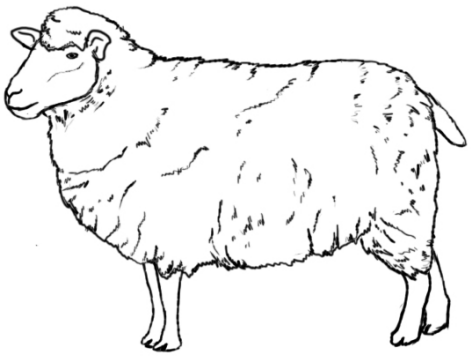
A Herdwick's grey fleece is not easily dyed, and is coarse, and so is best suited to use as carpet wool. The wool is also an excellent natural insulator; it is possible to buy sheets of fireproofed wool for insulation. Herdwick lamb and mutton has a very distinct taste, and was even eaten at Queen Elizabeth II's 1953 coronation banquet.

fell: (from Old Norse fell, fjall, "mountain"): a high and barren landscape feature, such as a mountain range or moor-covered hills.

heft: a small, local area

hefting (or heafing): the instinct in some breeds of keeping to a certain heft throughout their lives. Allows different farmers in an extensive landscape such as moorland to graze different areas without the need for fences, each ewe remaining on her particular area. Lambs usually learn their heft from their mothers.

SHEEP



Sheep are medium-sized, herbivorous mammals that graze on grass and berries. Sheep are mainly farmed for their meat and wool but sheep are also occasionally farmed for their milk (although milking sheep is much rarer than milking goats or cows). Sheep milk is most often used in cheese.

It is thought that the domestic sheep originated from central Europe and Asia. Today, there are at least 1 billion sheep on the planet, with commercial sheep farming most commonly found in New Zealand, Australia, parts of North America and the United Kingdom.

There are nearly 1,300 different species of sheep throughout the world with around 200 of these sheep being domestic sheep. All sheep species tend to be fairly similar in appearance but differ in size and weight depending on the species. The fleece of the sheep (the sheep's hair or wool) is one of the most widely used and common materials in the world.

The sheep is most closely related to the goat and although they are very similar, sheep and goats are two separate species of animal. Some visual differences include: a goat's tail usually points up while a sheep's tail hangs down. Sheep have woolly coats that require annual shearing. Goats are generally hairy and are not sheared as often. Some goats have beards, sheep do not, but some sheep have manes. Sheep have an upper lip that is divided by a distinct grove, goats do not. Goat horns are generally narrower and usually straighter than sheep horns.

Wild sheep tend to be larger than commercially farmed sheep or domestic sheep and one species of wild sheep is known to be around four feet tall, making the wild sheep a whole foot taller than the average sized domestic sheep. Wild sheep also have much longer horns which they use to defend themselves and wild sheep are also known to be great mountain climbers.

Due to their herbivorous diet, sheep have a complex digestive system that is made of four chambers, allowing sheep to break down cellulose from stems, leaves, and seed hulls into simpler carbohydrates. The digestive system of a sheep is similar to other animals that have a plant-based diet such as goats, deer and cows.

Sheep are a target prey for many large carnivorous animals such as dogs, wolves and wild cats. In order to protect themselves, sheep keep close together in a flock to make it harder for predators to kill a lone, unsuspecting sheep. In areas where sheep have no natural predators, the sheep are known to not display the flocking characteristics so strongly.

Most sheep species only breed once a year. Like other herd animals, a number of ewes (female sheep) will mate with just one ram (male sheep). Sheep tend to give birth to their lambs in the springtime so that the lambs have a long period of time to grow before the cold winter sets in. Female sheep tend to give birth to one lamb and sometimes twins.

Sheep play an important part in the agricultural economy around the world. Sheep were one of the first animals to be domesticated by humans and sheep are still vital in producing both wool and meat.

Girls Guides and Beatrix Potter

Beatrix Potter believed in sharing her love of nature and the outdoors with other children. She arranged for groups of Girls Guides to camp on her property for many years. On her 70th birthday, the Girl Guides surprised her with a special party. They came to her farm dressed as characters from her books.

Girl Guides are similar to Girl Scouts in the U.S. In 1909, a group of girls appeared at a Boy Scout Rally in the UK declaring themselves to be Girl Scouts. Lord Robert Baden-Powell, the founder of Boy Scouts, decided that there should be an organiztion for girls.

Guiding was introduced that same year to respond to the specific needs of girls and young women. Groups of Girl Guides soon started in Australia, Canada, Denmark, Finland, New Zealand and South Africa.

A year later, the Girl Guide Association was officially established in the UK under the leadership of Agnes Baden-Powell, Robert's sister. By 1912 there were also groups in Ireland, Portugal, Norway. Juliette Low founded Girl Scouting in the USA in 1912.

The movement continued to grow over the years, and today there are Girl Guide or Girl Scouts Associations in 146 countries!

Girlguiding UK

Girl Guides in the United Kingdom
http://www.girlguiding.org.uk

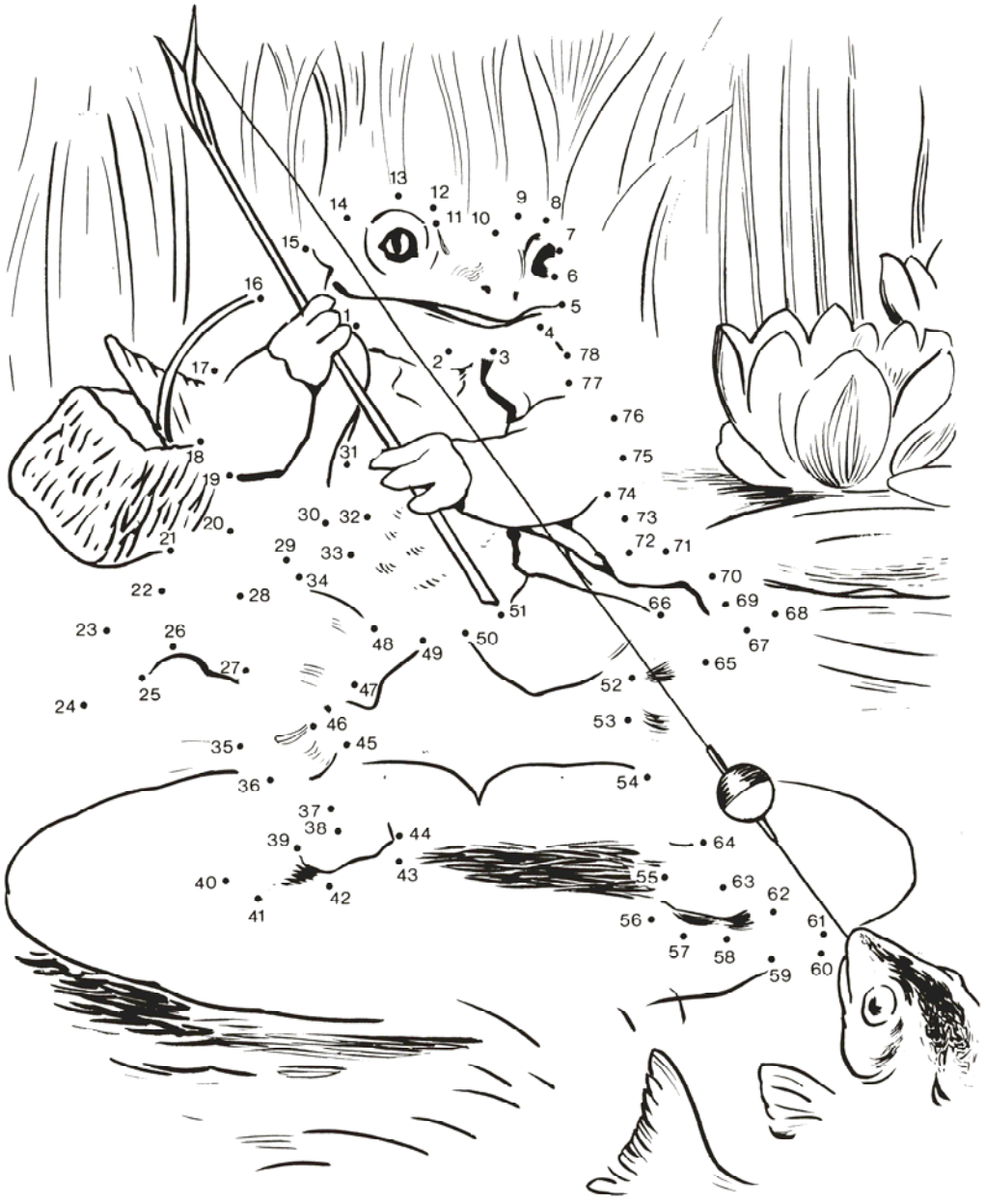
World Association of Girl Guides & Girl Scouts
https://www.wagggs.org

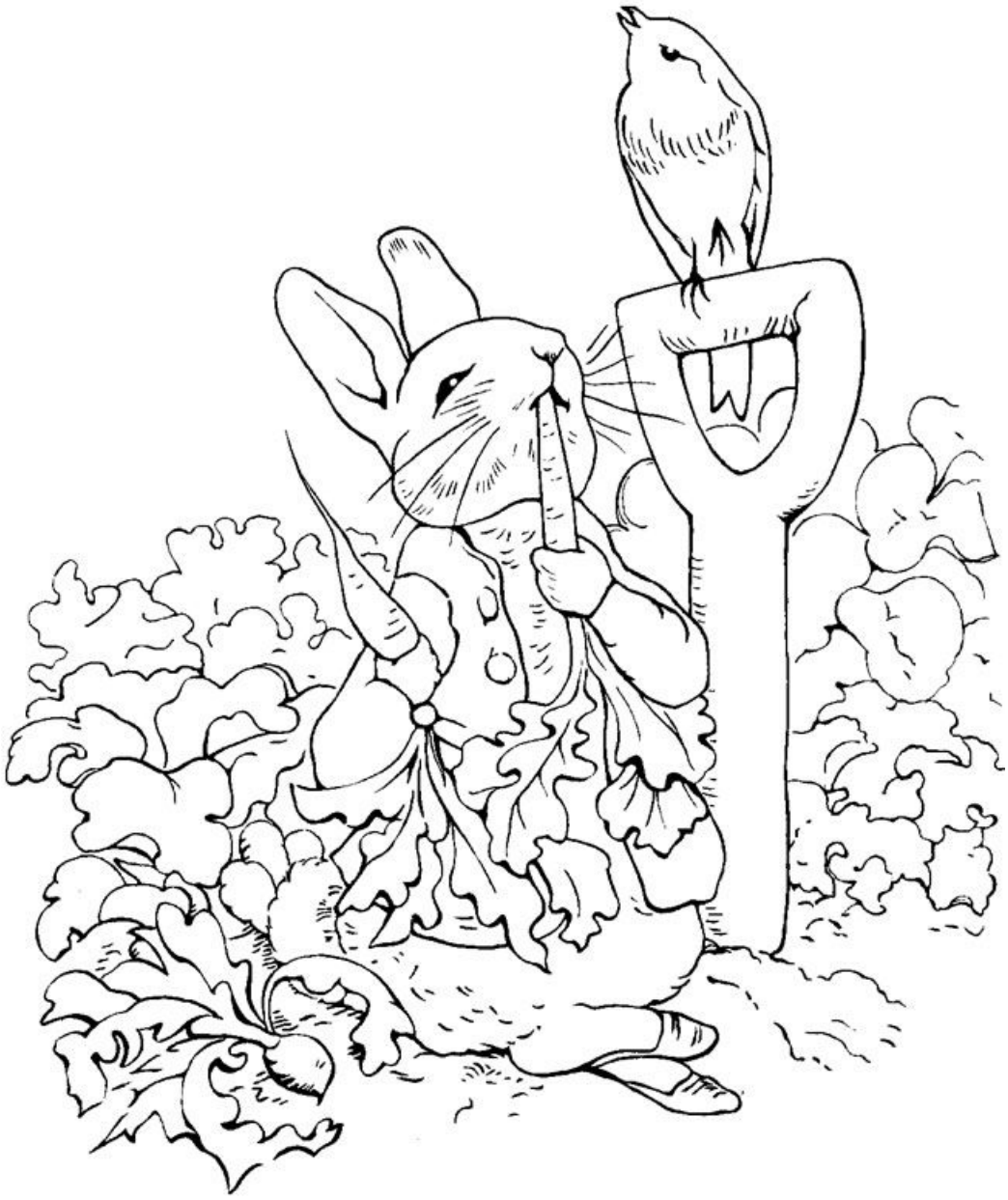
BEATRIX POTTER

From photographs with her rabbit, Peter, left, and her dog, Spot, right.

Join the Dots

Join the dots to find out who this is.
When you have finished you can paint or colour it in.





First he ate some lettuces and some French beans; and then he ate some radishes;