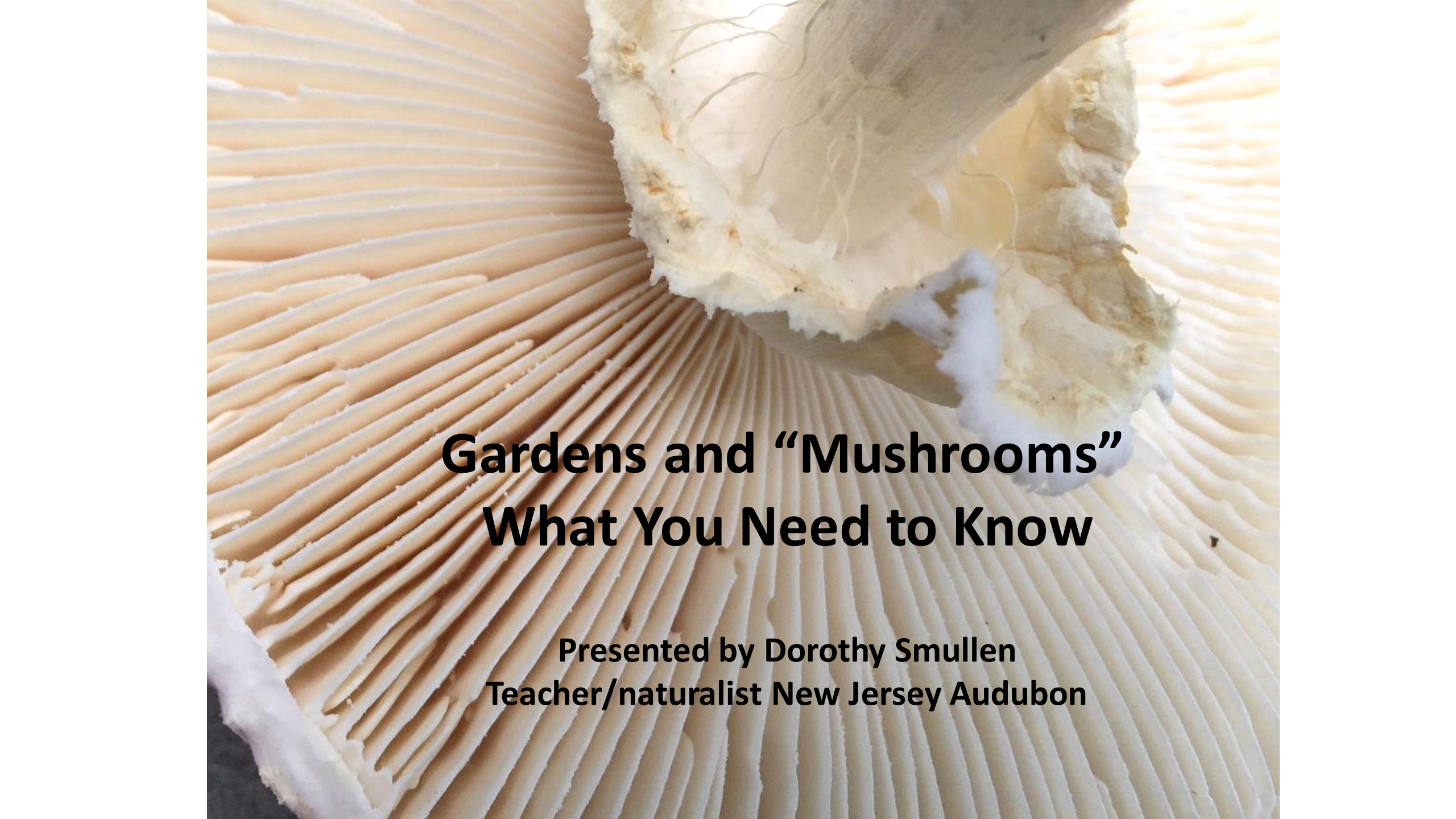


A close-up photograph of a mushroom, likely a chanterelle or similar gilled mushroom. The cap is thick and white, with numerous closely spaced, light-colored gills. The stem is also white and appears fibrous or woody, with some internal structure visible where it has been torn or cut. The background is a soft, out-of-focus light color.

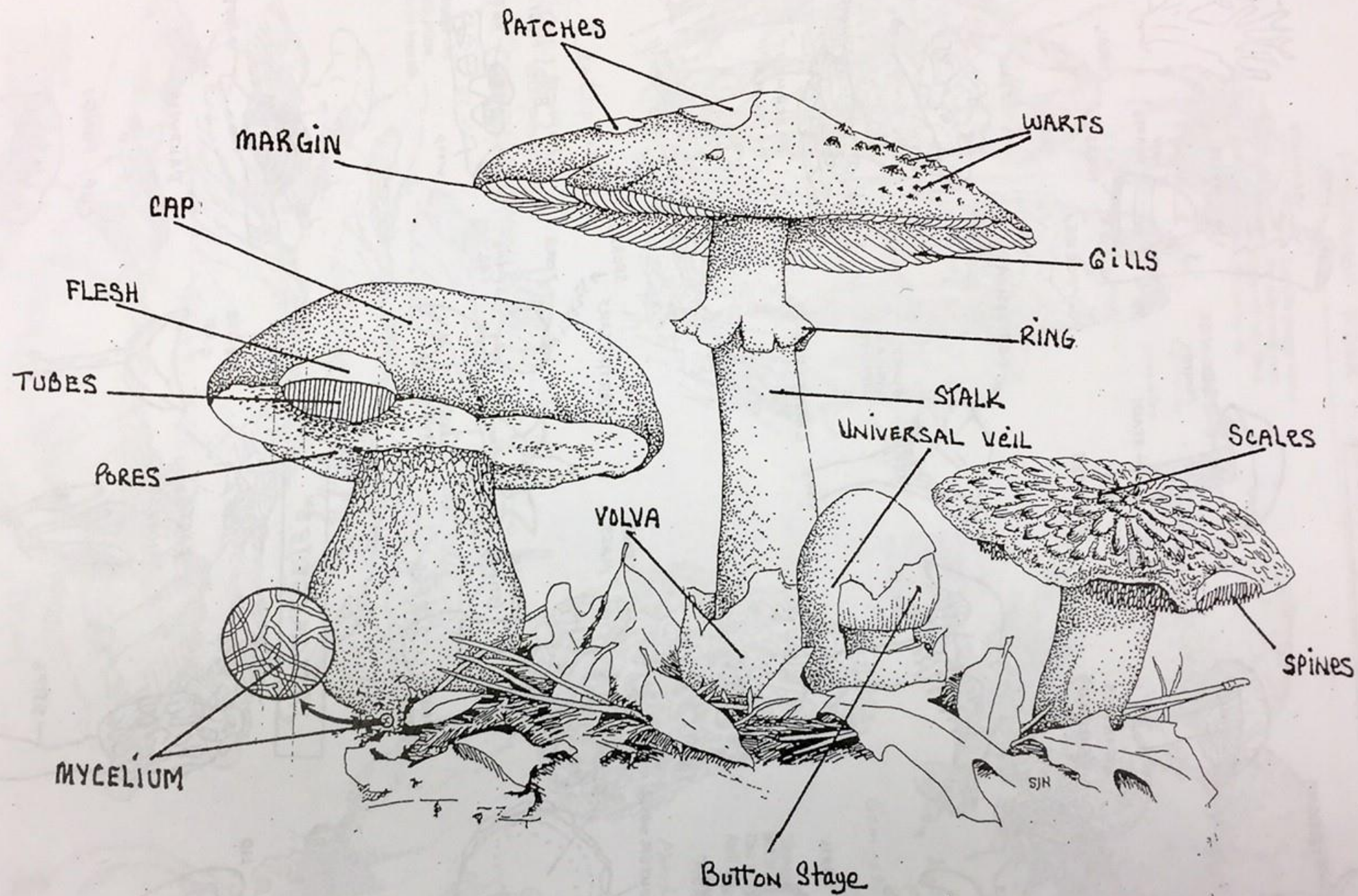
Gardens and “Mushrooms” What You Need to Know

**Presented by Dorothy Smullen
Teacher/naturalist New Jersey Audubon**

Outline of Presentation

- *What are mushrooms – part of Fungi kingdom
- *Importance including lichens
- *Healthy soils and the Mycorrhizal Connections
- *Ways to ID common garden fungi



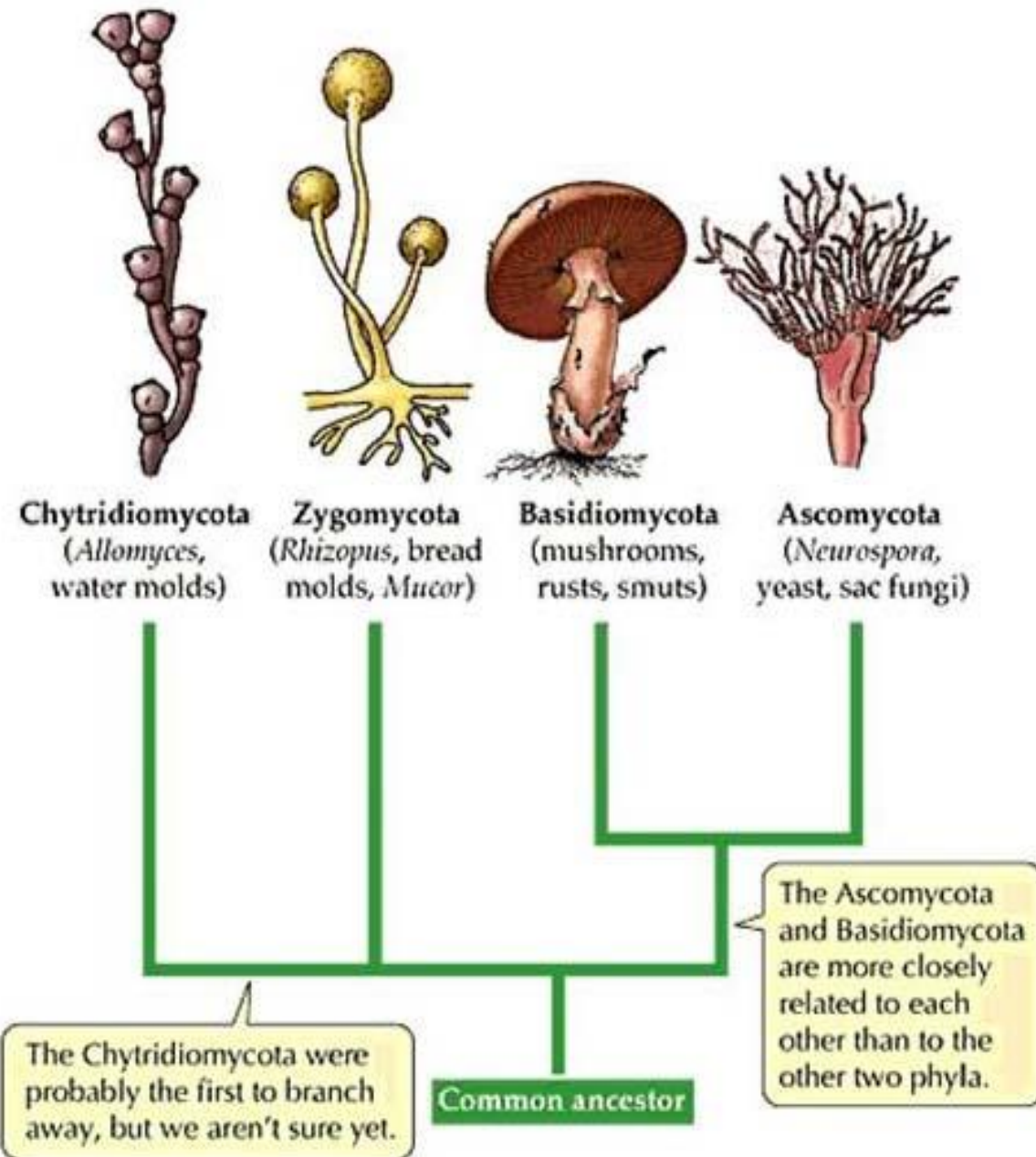


Other Fungi “Groups”



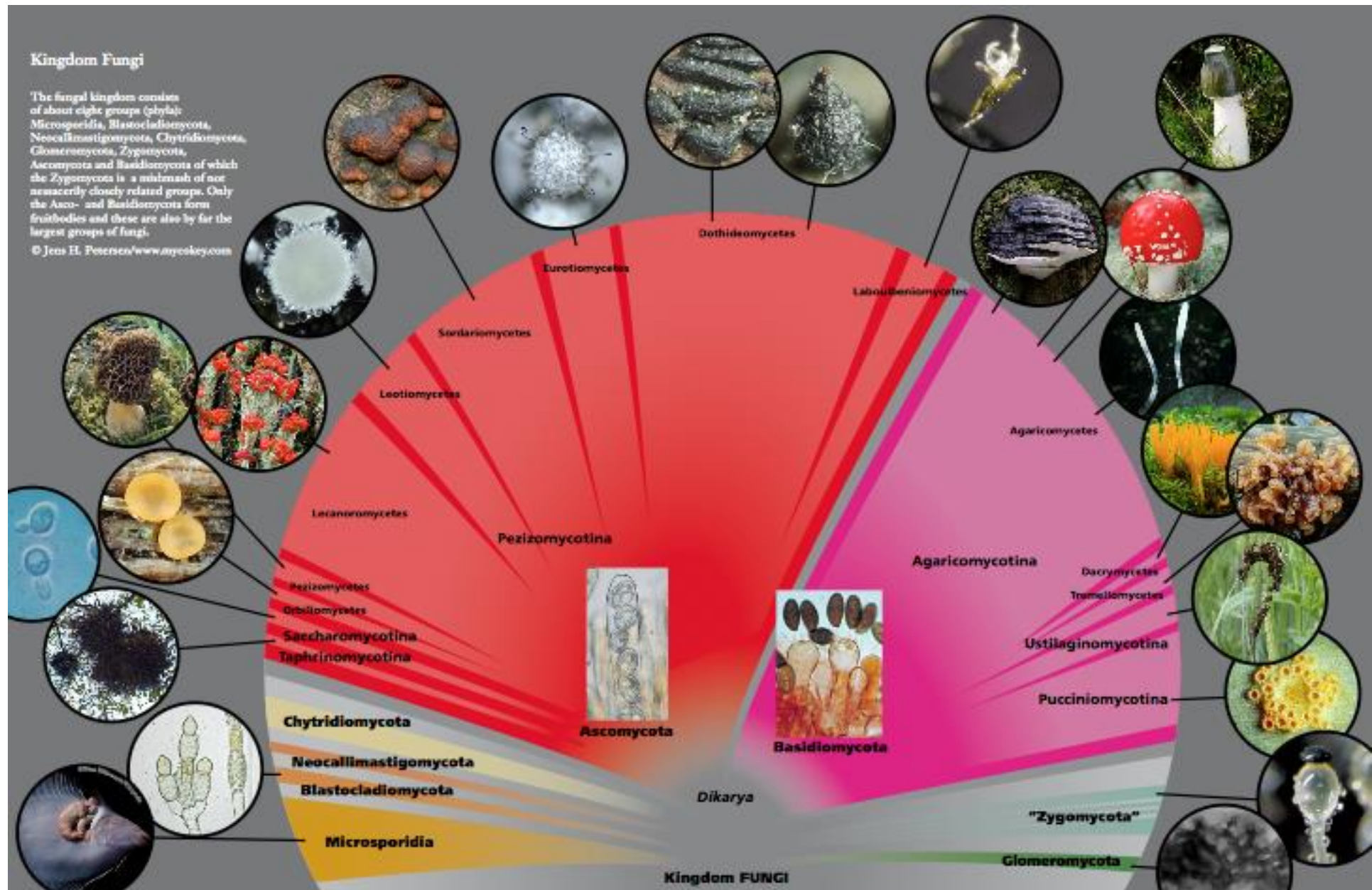
Kingdom Fungi

- Eukaryotes
- **Cell wall** made of **chitin**, a carbohydrate
(same compound as exoskeleton of insects!!!!)
- Most **multicellular**: mushrooms, molds
- Some **unicellular**: yeasts
- **Heterotrophs**: - **decomposers**
- **some parasites** -mycorrhizae
- Body made is made of filaments called **hyphae**
- Reproduce using **spores**



Evidence from 485 mya that fungi symbiotic with first land plants

Numbers of species 140,000 named – estimates millions



Importance in the Ecosystem as DECOMPOSERS



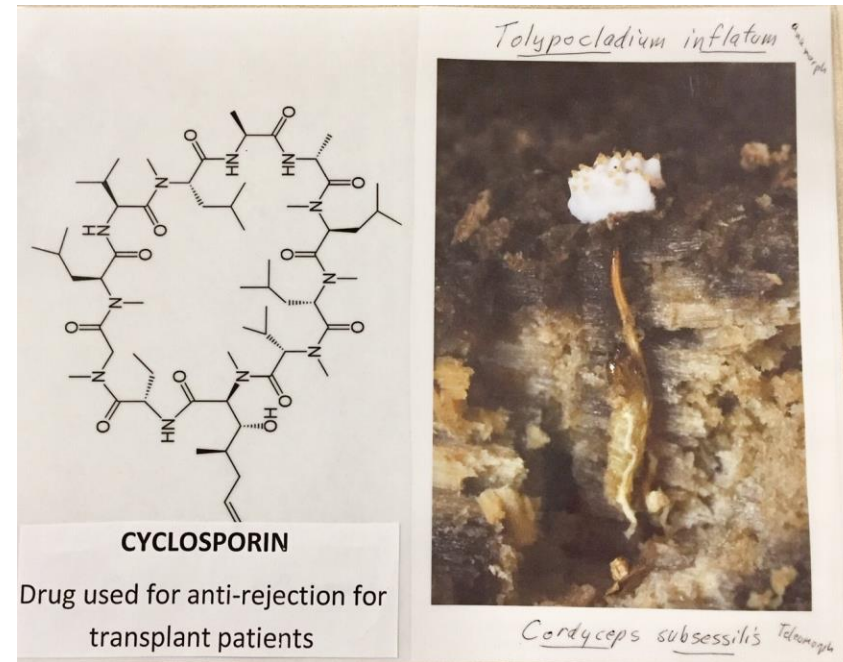
Cuboidal Brown Rot



Food for Wildlife



Medicine for Humans



Importance of LICHENS – indicators of air pollution



Nesting material for birds



Flying squirrel nest



Reindeer winter food



Lacewing larvae camouflage

MYCORRHIZAE



White material
Is the hyphae of
The fungus



Mycorrhiza – means fungus-root, named by Frank (1885) for non-pathogenic symbiotic associations between roots and fungi.

Mycorrhizas are symbiotic associations essential for one or both partners between a fungus and a root of a living plant, that is primarily responsible for nutrient transfer. Brundrett 2004



Categories of Mycorrhizal Associations

***Arbuscular (AM) or Vesicular-arbuscular (VAM)**

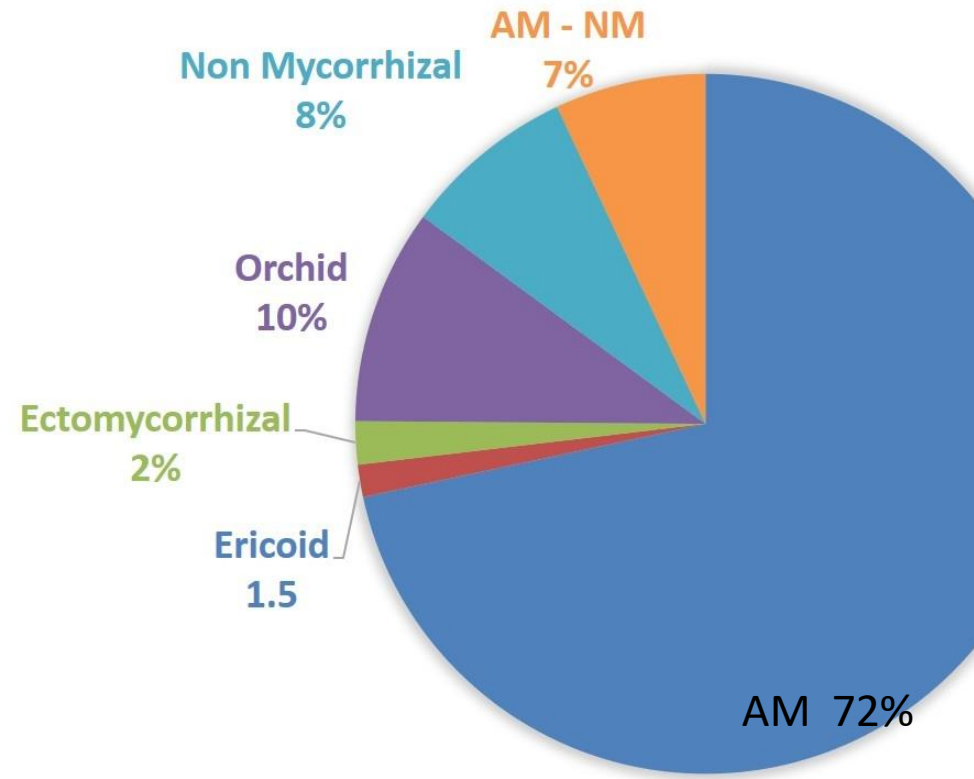
***Ericoid**

**Arbutoid
Monotropoid**

***Orchid**

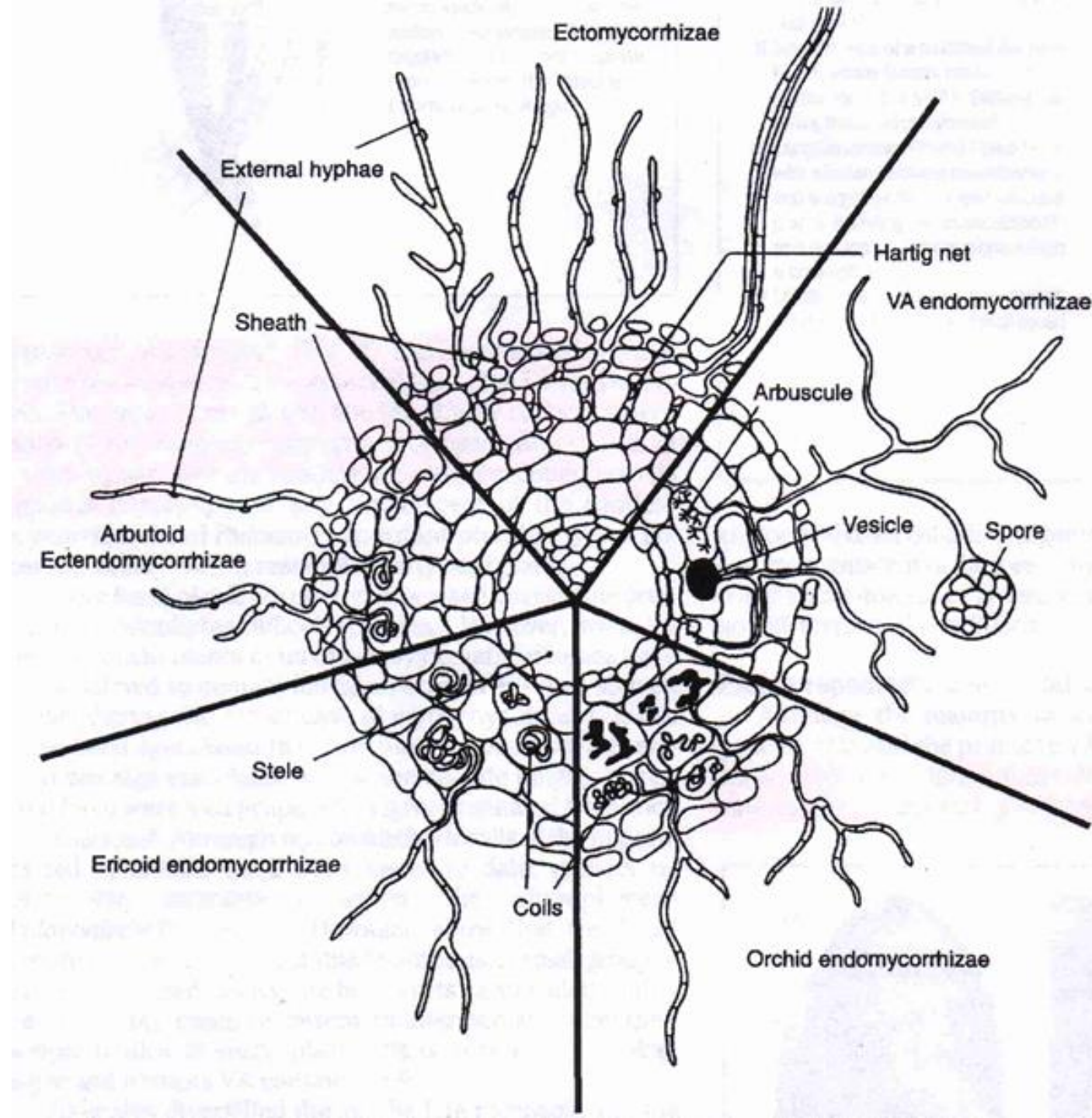
***Ectomycorrhiza (ECM) (EM)**

***Ectendomycorrhizae**



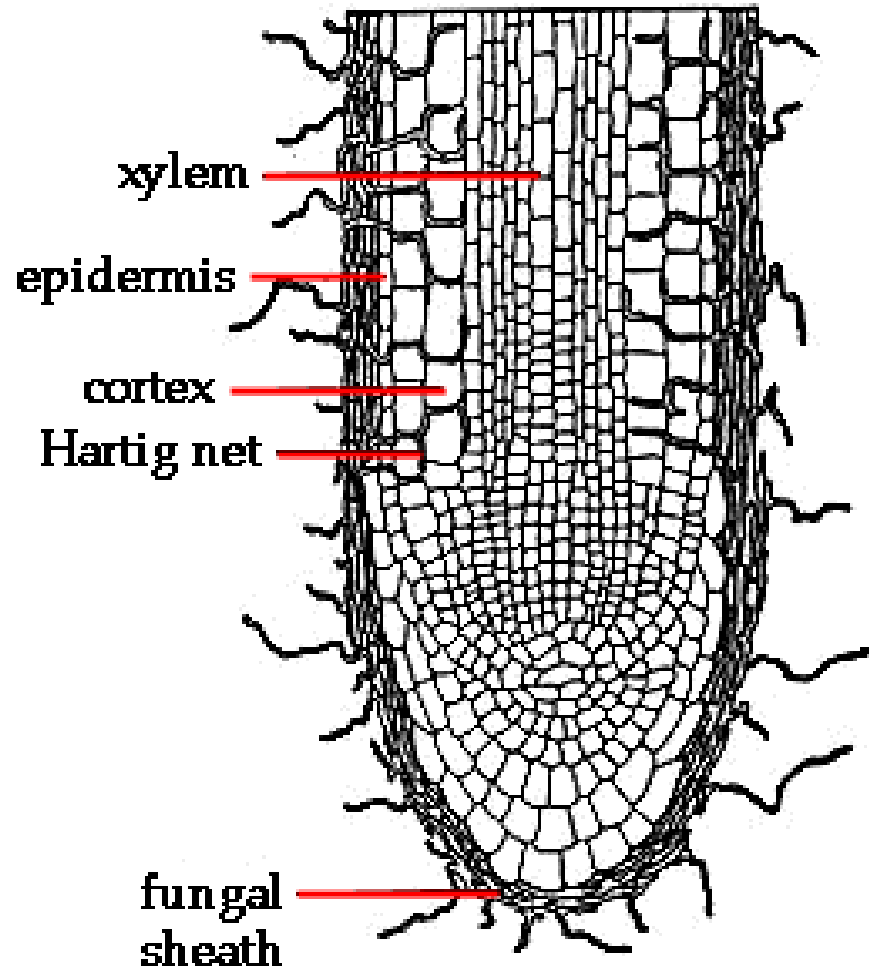
Based on:
Evolutionary history of mycc
Brundett, Tedersoo, Tansley

**Over 80% of vascular plants
are mycorrhizal
Over 90% of angiosperms**



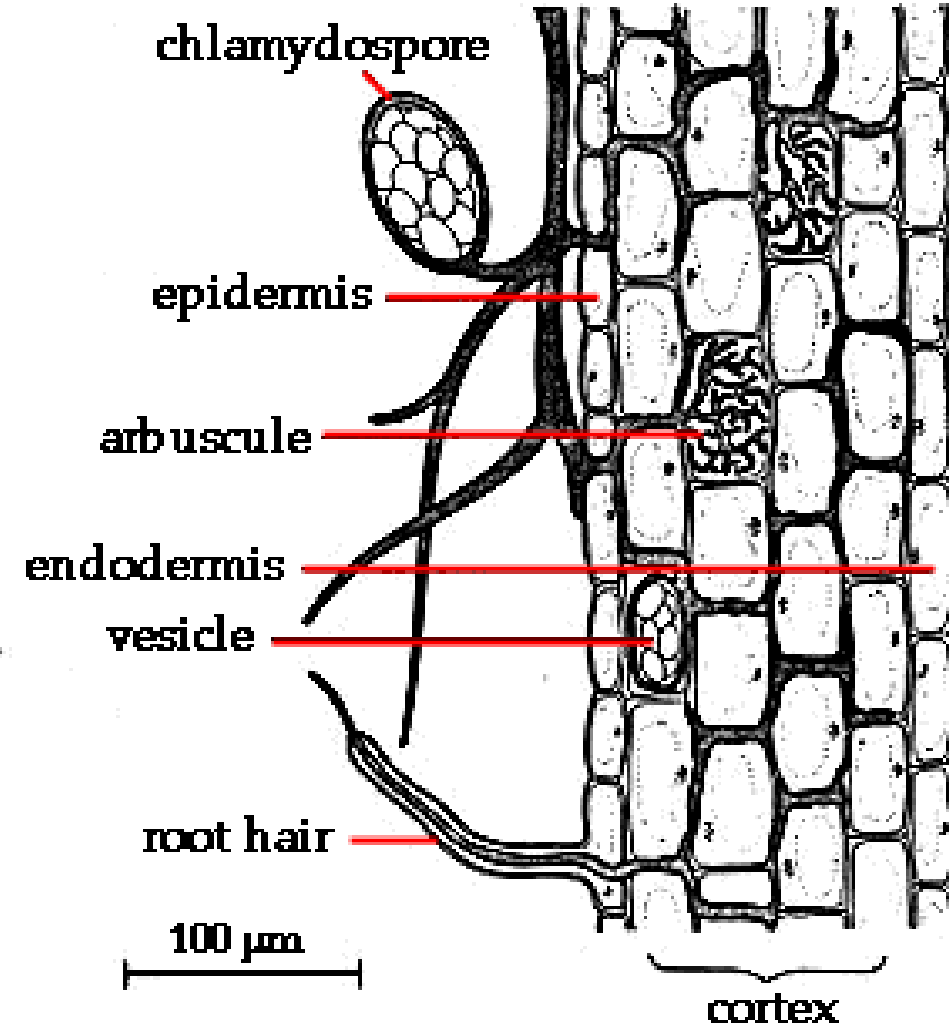
AM

Ectomycorrhizae



AM

Endomycorrhizae



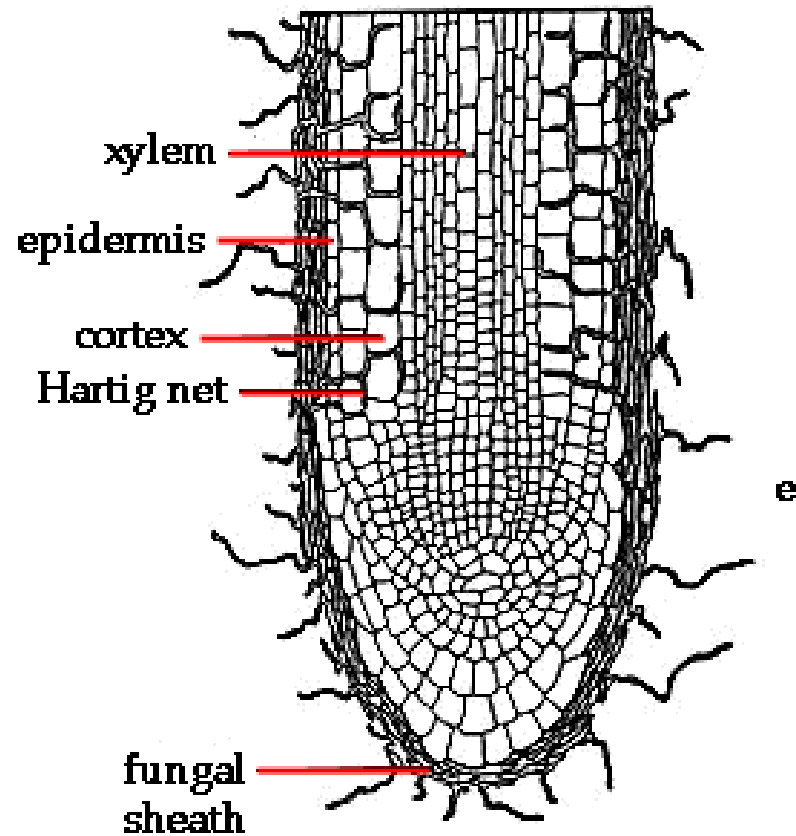
ECTOMYCORRHIZAS – ECM

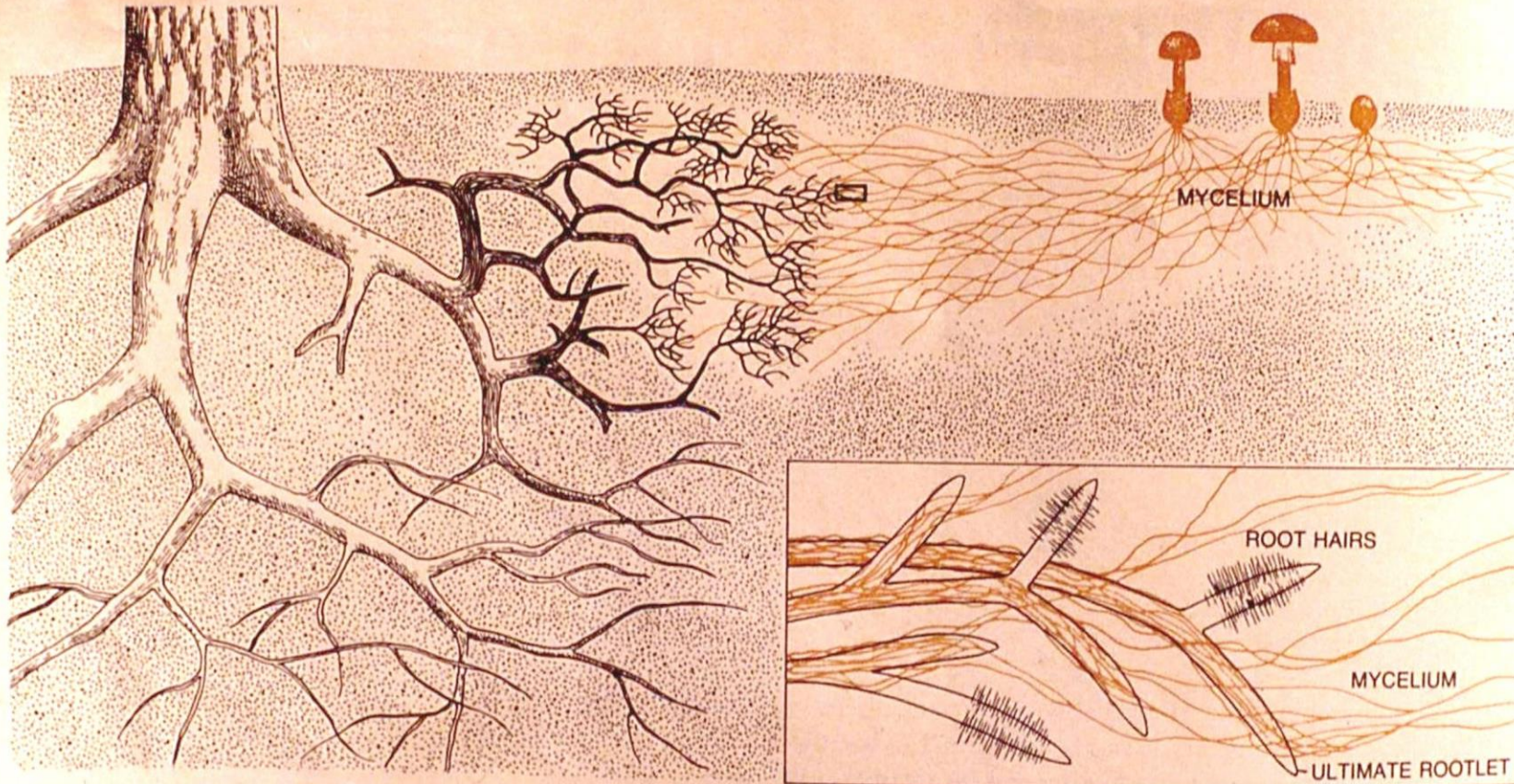
Usually visible hyphal coverings on short root root-tips

Extracellular

Over 6,000 species of fungi involved

Ectomycorrhizae





STRUCTURE OF A FUNGUS includes not only the mushroom but also the mycelium: a network of hyphae, or filaments, that permeate the soil or some other medium. Some mycelia participate in a symbiotic association with higher plants in which the hyphae (color) and the ultimate rootlets of a tree (black) form a joint structure called the mycorrhiza (detail drawing). Many amanitas,

and perhaps all of them, form mycorrhizae. The mycelium can live for many years, invading new territory as it grows; the mushroom, on the other hand, is an ephemeral reproductive body that appears in season and decays in a few days or weeks. Its only function is to produce and disperse microscopic spores that, if they come to rest in a suitable habitat, can germinate to establish a new mycelium.

Amanita, Lactarius, Russula, Boletes, False truffles, Morels

ECM PLANTS

Major Forest Trees

Pine

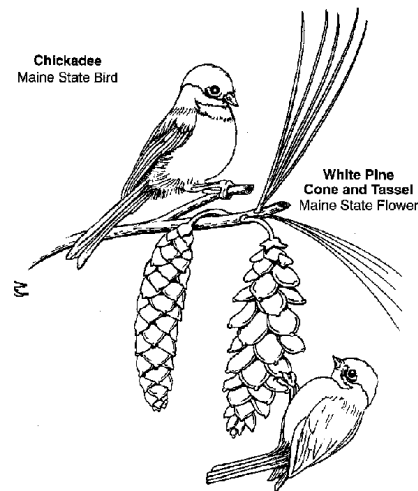
Spruce

Hemlock

Larch

Fir

Arborvitae



Basswood

Beech

Chestnut

Birch

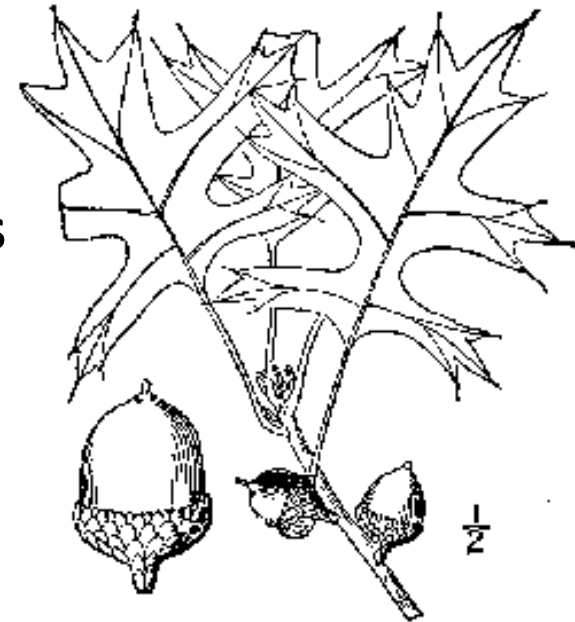
Cottonwood

Hickory

Oak

Willow

Eucalyptus





BBC Video – WOOD WIDE WEB

AM and VAM

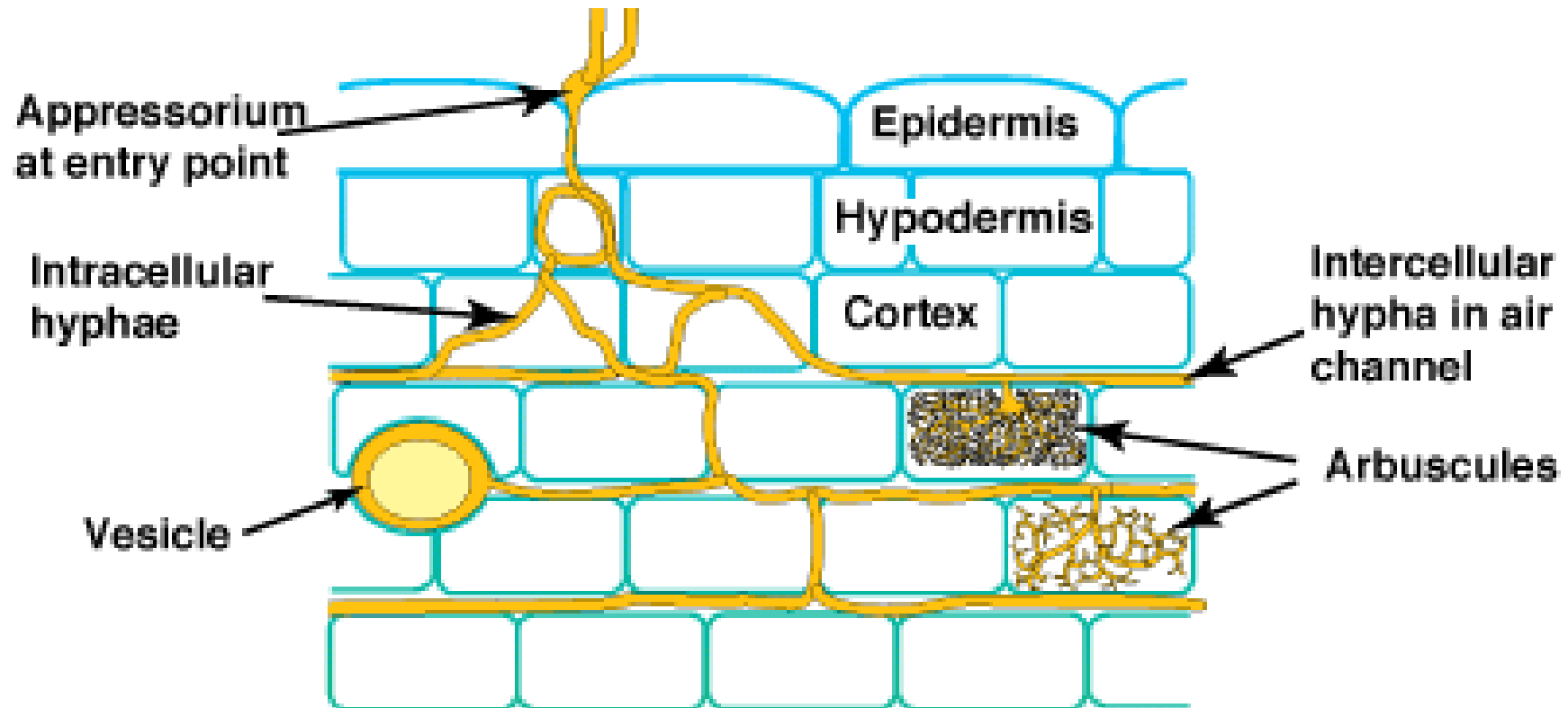
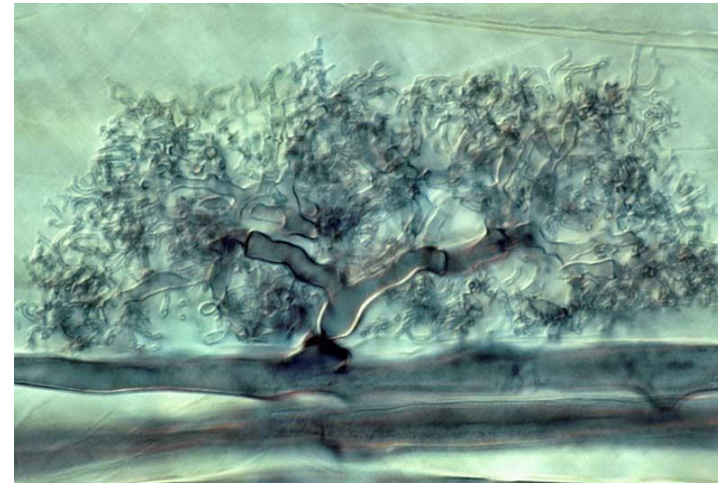
Mycorrhizas

Endomycorrhizal

Not visible without microscope

Intracellular

200 species of fungi

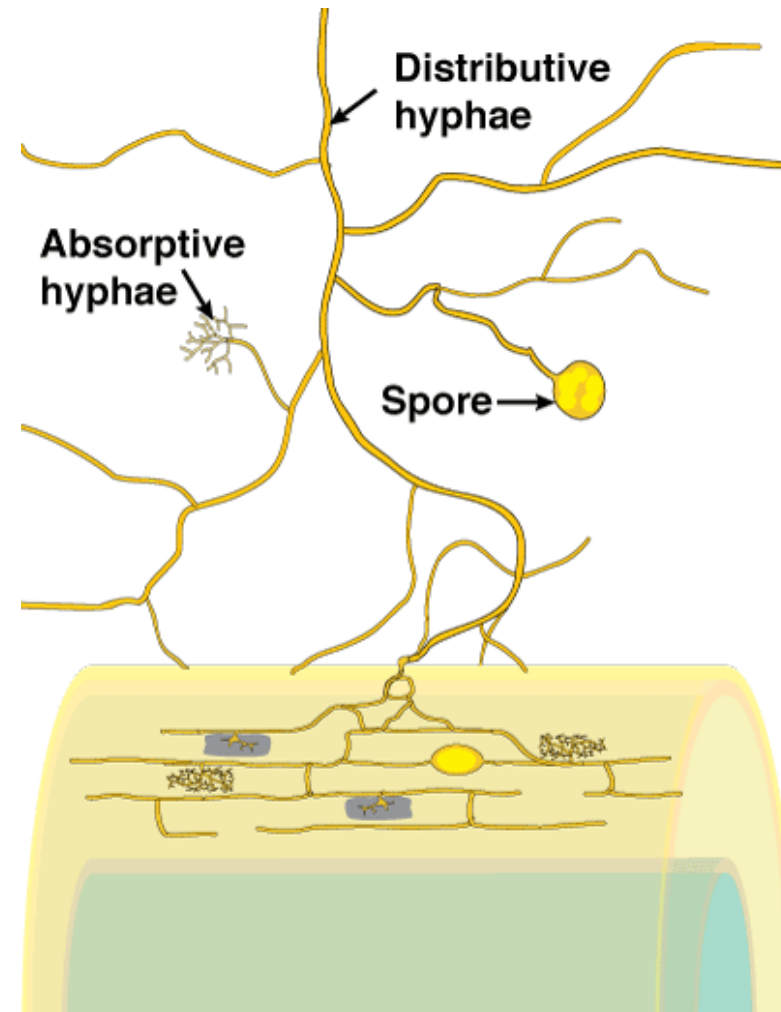
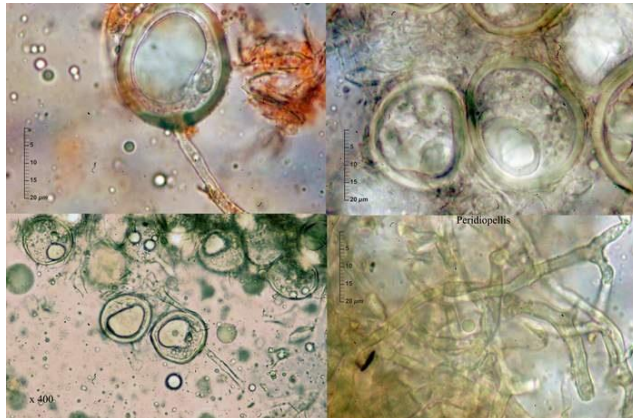


AM - What Fungi? GLOMEROMYCOTA

Glomus, *Acaulospora*, *Scutellospora*



Glomus microcarpum



AM PLANTS

75% of Vascular Plants

Herbaceous



**Grasses
Cotton
Corn
Pepper
Tomato
Sorghum
Legumes
Most
agronomic
and forage
crops**

Woody

**Sycamore
Black Walnut
Sweetgum
Citrus
Peach, Cherry
Black Locust
Green Ash
Maples
Dogwood
Magnolia**



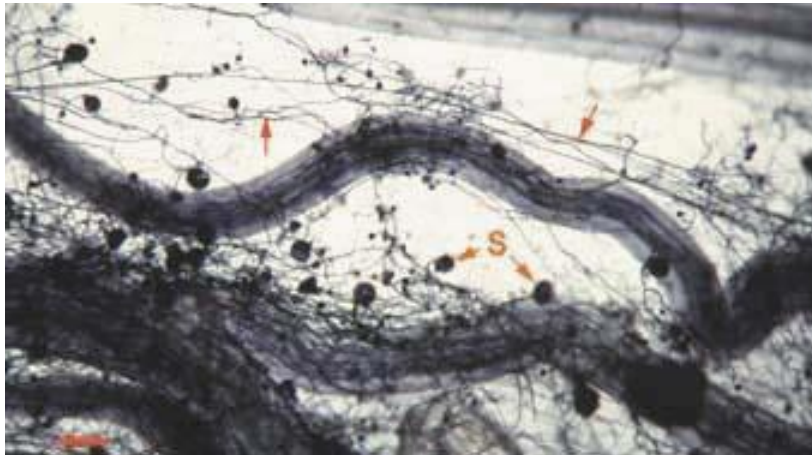
Importance of AM (and ECM)

Plant Benefits:

- *Provide plant roots with phosphorus (usually phosphorus becomes immobilized in soils) Even legumes need high phosphorus requirement for *Rhizobium* nodule formation.
- *Uptake of nitrogen and micronutrients from greater surface area of hyphae and greater extension into soil by hyphae
- *Uptake of water and increased tolerance to drought
- *Increased yield and reproductive success

Fungus Benefits:

- * Receiving simple carbohydrates, amino acids and vitamins



Lower Devonian fossils
of early land plants
(400 mya) have shown
AM fungi

MYCORRHIZAL SYMBIOSIS BENEFITS TO PLANTS

NUTRITION

- Increases surface area of nutrient uptake
- Unlocks phosphorus for plants
- Acquires nitrogen from organic matter
- Improves uptake of trace minerals
- Enhances nutrient density of crops

SEEDLINGS

- Prevents "damping off" disease
- Reduces transplant shock
- Supports root initiation on cuttings

FIELD AND FOREST

- Stabilizes soil aggregates
- Sequesters carbon
- Improves plant growth and yield
- Delivers moisture as needed
- Augments deeper root penetration
- Suppresses root pathogens

PRACTICAL ADVANTAGES

- Mediates heavy metal toxicity
- Helps plants cope with soil salinity
- Breaks up subsoil compaction layer
- Suppresses nonmycorrhizal weeds
- Cuts fertilizer requirements
- Improves tolerance of higher soil temperatures

HEALTHY PLANT METABOLISM

- Improves rate of photosynthesis
- Plays cofactor role in protein synthesis
- Provides reserve energy in lipid form
- Stimulates induced systemic resistance

MYCORRHIZAL NETWORKING

- Ensures balanced nutrient uptake
- Ensures healthy forest succession
- Facilitates plant-to-plant communication
- Provides the foundation for ecosystem resiliency

CAN SOIL FUNGI FIGHT CLIMATE CHANGE?

Keys to mitigate global warming hide beneath our feet

Michael P. Amaranthus¹ and James M. Trappe²

¹PO Box 1181, Grants Pass, OR 97528, dr mikeamaranthus@gmail.com; ²USFS Pacific Northwest Research Station, Forestry Sciences Laboratory, Corvallis, OR 97331, trappej@gmail.com

Abstract: Rapidly increasing CO₂ levels in the atmosphere are resulting in abrupt changes in climate that threaten food production and ecological systems. Soils are crucial to managing climate change. They contain two to three times more carbon than the atmosphere. Arbuscular mycorrhizal fungi form a symbiotic relationship with the majority of our important crop species. How to capture carbon dioxide from the atmosphere? A good opportunity is to “plant” carbon in soils and crops via arbuscular mycorrhizal fungi on millions of acres of farmland. Arbuscular mycorrhizal fungi and associated soil microorganisms produce the sticky protein glomalin that results in vast

Introduction

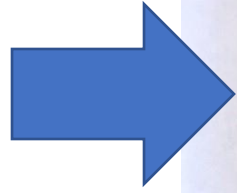
Mushroom hunters are accustomed to keeping their heads down, looking for choice, edible fungal prizes. Certainly, harvesting wild edible mushrooms can be a joyous and life-long endeavor. But, sadly, only about 10% of earth's several million fungal species produce mushrooms. The majority not producing mushrooms, however, provide vital ecosystem functions. No fungal group is more important than the arbuscular mycorrhizal fungi. These tiny species are critical to life on Earth. The term “arbuscular” is from Latin for “little bushes” referring to the microscopic fungal structures formed in host root cells in the shape of tiny bushes (Fig. 1).

Arbuscular mycorrhizal fungi (formerly known as endomycorrhizal

fungi) form a symbiotic relationship with most of our important crops as well as wild plants. Most grasses, wildflowers, agricultural plants, and woody plants form arbuscular mycorrhizae (Taber, 1990; Trappe, 1987; Wang and Qiu, 2006). These host plants produce photosynthates to fuel the activities of arbuscular fungi colonizing their roots. The fungi, in return, pull nutrients and water from the soil for use by the host plants. Miles of arbuscular fungal filaments can be present in a tablespoon of healthy soil (Fig. 2). Instead of producing specialized fruiting body structures such as mushrooms, truffles or puffballs with masses of spores, the arbuscular mycorrhizal fungi instead produce individual or clustered spores inside and outside the roots (Fig. 3).

Arbuscular fungi dramatically increa

Fungi magazine
Fall 2021

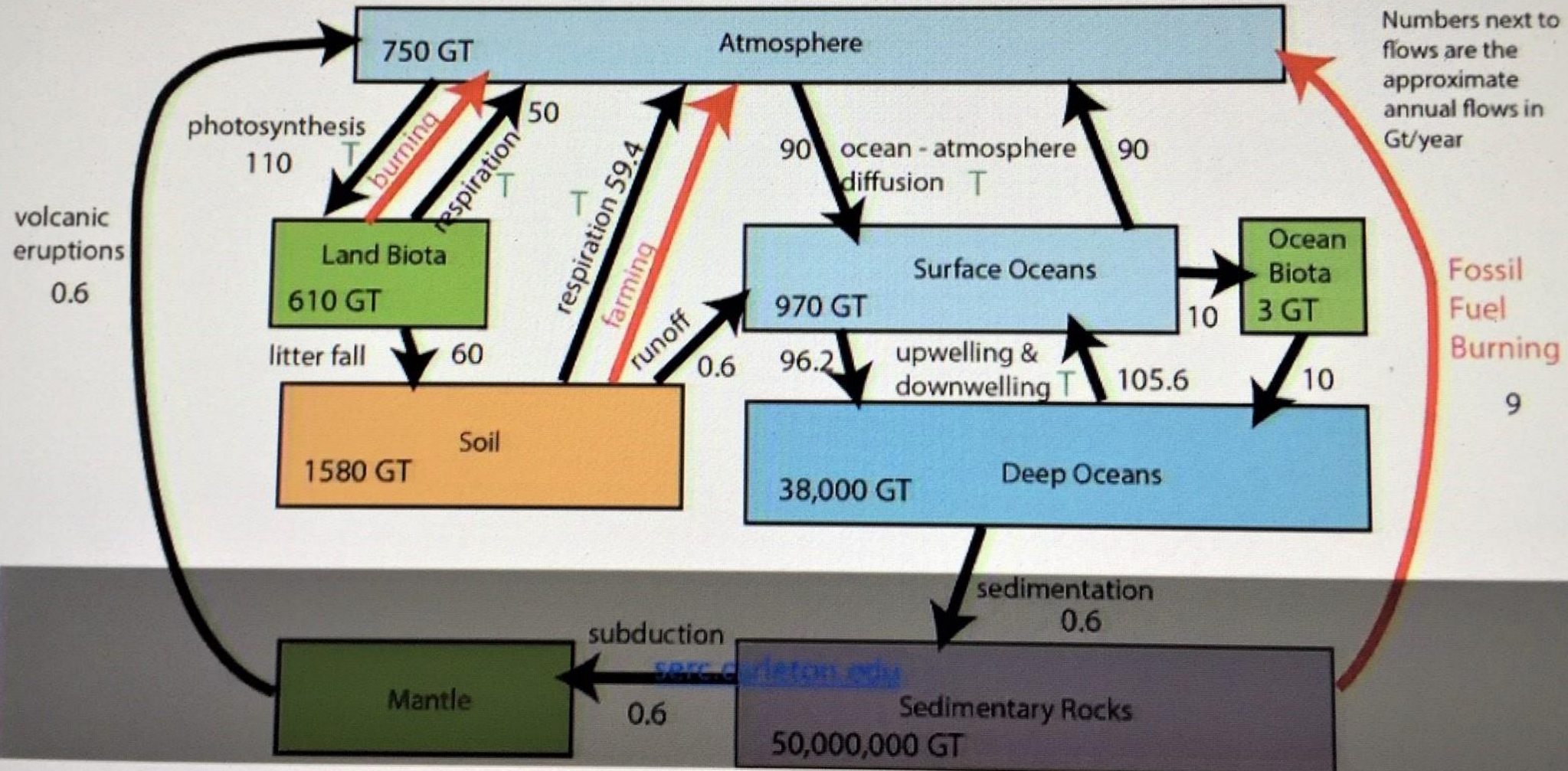


Arbuscular mycorrhizal fungi and associated soil microorganisms produce the sticky protein glomalin that results in vast carbon sequestration and carbon storage in soil. Arbuscular mycorrhizal fungi also have the ability to directly absorb organic nutrients from soil and increase net primary productivity in stressful environments that significantly increases carbon accumulation during crop production. Managing soil to promote mycorrhizal fungi...

The Global Carbon Cycle

units are gigatons of carbon — one gigaton = one billion metric tons = 10^{15} g

Red arrows are flows that are related to human activities
Green T = flows sensitive to temperature



Essential for Mycorestoration:

1. "A mere 2 % increase in soil carbon could offset a large percentage of greenhouse gas emissions going into the atmosphere."

White (2014)

- return ppm to 350 in a few decades

Jehne 2019

2. Soil holds more than twice the amount of carbon dioxide than the atmosphere and vegetation combined.

Peter Donovan

3. For every gram of C returned to soil, it can hold 8 grams of water.

4. Mycorrhizal fungi play a key role in carbon storage –glomalin!

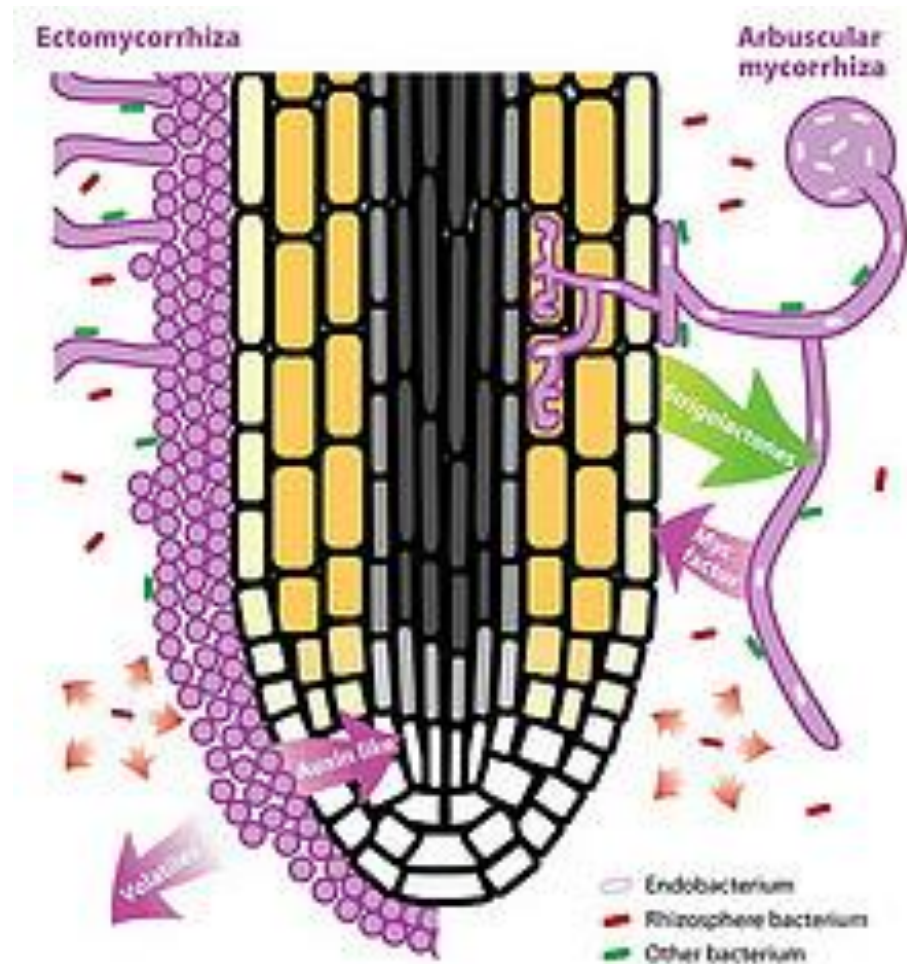
5. REBALANCE the CARBON CYCLE!

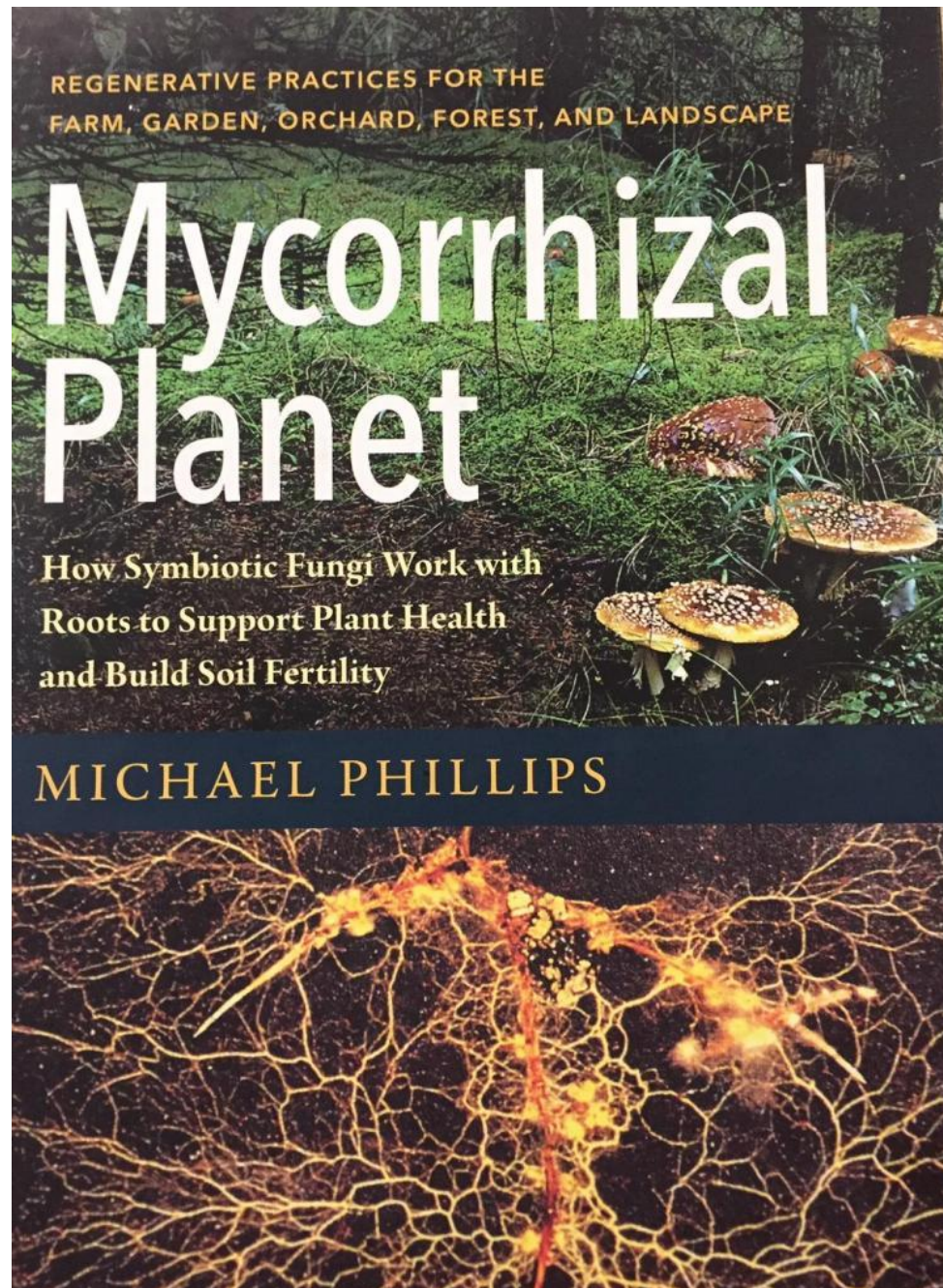
Sue Van
Hook
2022

Importance of No-till Agriculture

Carbon sequestration in field and forest

Habitat restoration in poor soil





2017
By Michael
Phillips

Search online
BBC video
Called "Wood Wide Web"

Encouraging Mycorrhizal Connections

Diversify your native plants

Do not over-fertilize especially phosphorus

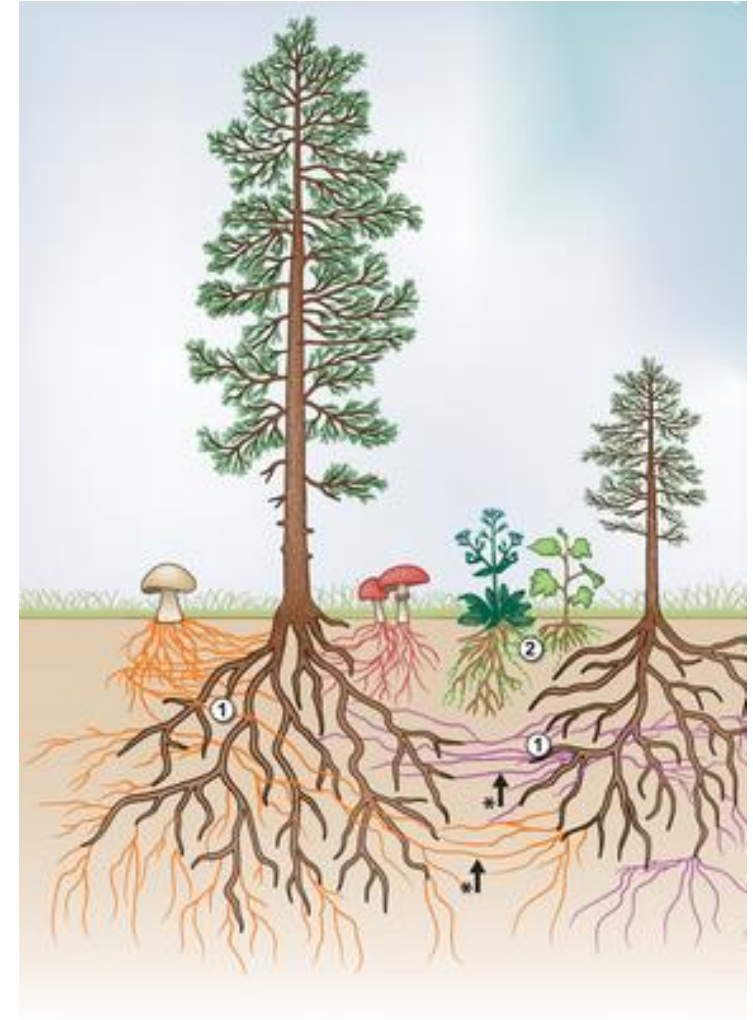
Do not till – breaks up existing mycelium

Compost and mulching – a good idea

Crop rotation for large vegetable gardens

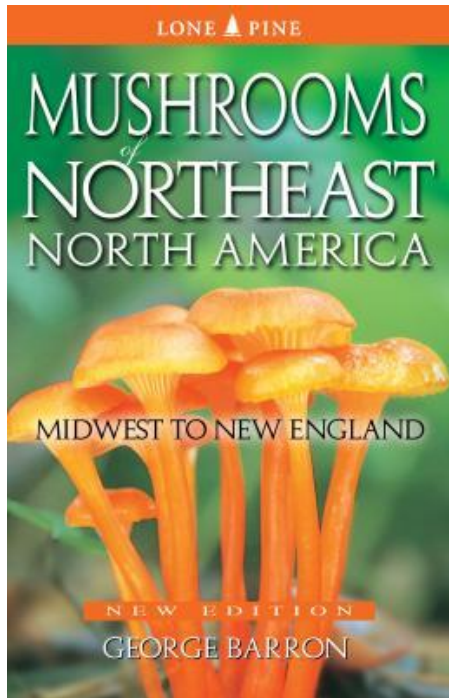
Avoid expensive products – mycorrhiza already there

Avoid pesticides to soil area



Ways to Identify Common Fungi in Gardens

Field Guides



iNaturalist

Who you are

You'll need to make an **iNaturalist** account and please only post your own personal observations

Where you saw it

Record both the coordinates of the encounter as well as their accuracy. You can obscure the location from the public

What you saw

Choose a group of organisms like **butterflies** or better yet a specific organism like the **Monarch butterfly**. If you provide evidence you can leave this blank and the **community** can help

When you saw it

Record the date of your encounter, not the date you post it to iNaturalist

Evidence of what you saw

By including evidence like a **photo or sound**, the community can help add, improve, or confirm the identification of the organism you encountered. Help the community by taking clear well framed photos, by including multiple photos from different angles

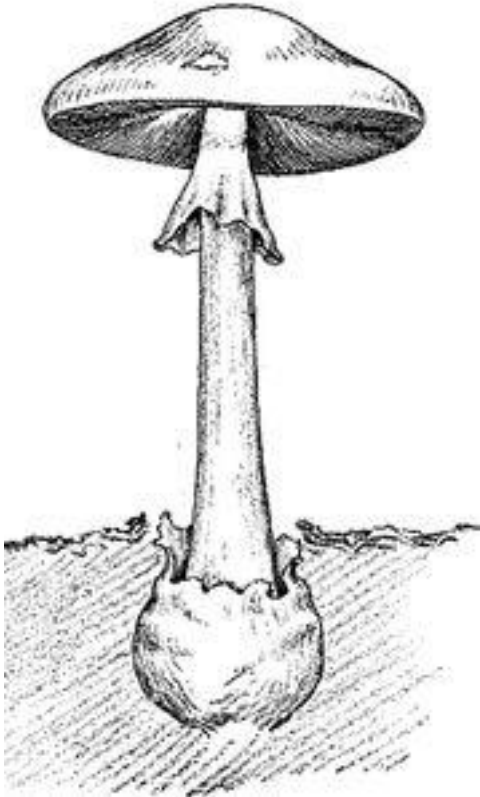


Join New Jersey
Mycological
Association

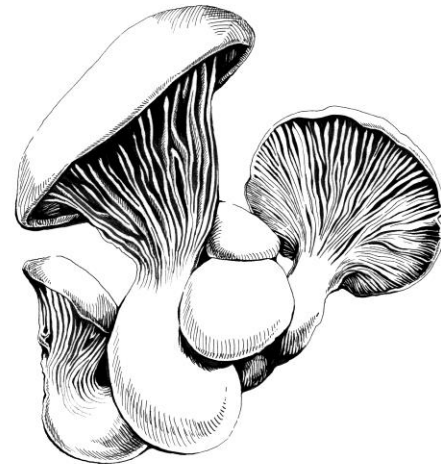
www.njmyco.org

What to do when you find a mushroom in your garden that you want identified

NO MUSHROOM IS POISONOUS TO TOUCH



- Note where it is growing – lawn, mulch, log or live tree
- Is there just one or is there a cluster
- What are the colors and surface of stem and cap -
- Check the basal part – if more underground, dig out
- What is under the cap – pores, gills or spines?
- Take photographs of top, side and base views on gray paper
- Put a coin or ruler in photo to judge size
- If time – take a spore print
- If gills under the cap – do they attach to stem or are they free?

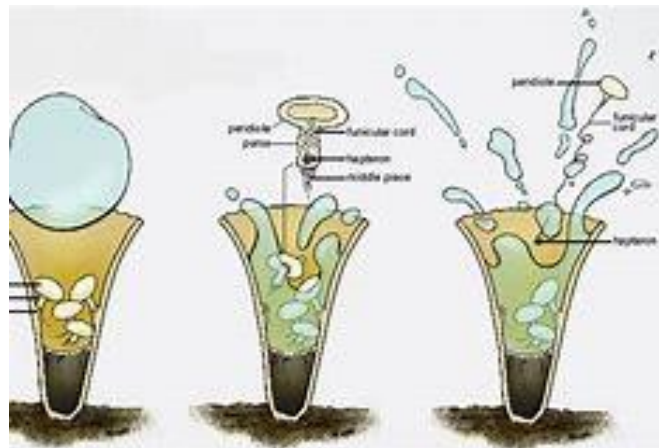
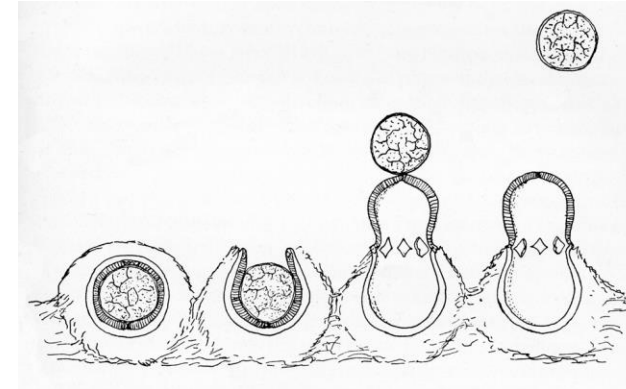


FUNGI IN WOOD CHIPS

Bird's Nest Fungus – several genera



Artillery fungus – *Sphaerobolus* sp.



Fuligo septica – **Dog Vomit Slime Mold**

Moving protoplasm into powdery fruiting body





Stinkhorn Fungi



TREASURES FROM THE KINGDOM OF FUNGI™

A MYCO-ADVENTURE THROUGH PHOTOGRAPHY BY TAYLOR F. LOCKWOOD

