

Advanced Production of Specialty Mushrooms in Arizona



COLLEGE OF AGRICULTURE
AND LIFE SCIENCES
COOPERATIVE EXTENSION

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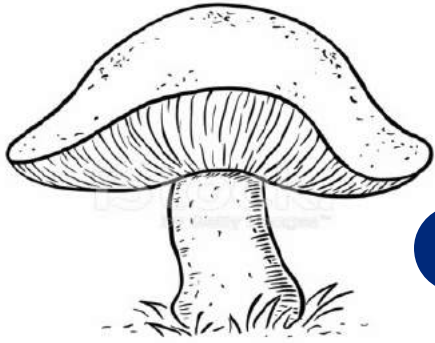
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Establishing mushroom production in Arizona



Arizona Mushroom Growers Association

- ✓ **Funded by the Arizona Department of Agriculture Specialty Crops Block Grant program, 2015 and 2017**
- ✓ **Providing cultures, resources, research, expertise, and training to assist small businesses integrate mushroom production into diversified farming systems**
- ✓ **Currently 115 members representing production in 12 of the 14 counties**
- ✓ **Everyone can join!! <http://www.azmushroomgrowers.org/>**

Arizona Mushroom Growers Association

Advanced Workshop

Tucson, AZ 9/7/18

Schedule/Itinerary

- 1:00 - 1:15 - Introductions and backgrounds
- 1:15 - 1:45 - Kinds of specialty mushrooms
- 1:45 - 2:15 - Types of substrates
- 2:15 - 2:30 - Short Break
- 2:30 - 3:00 - The pasteurization process
- 3:00 - 3:45 - Hands-on: Culture Transfers and Inoculation
- 3:45 - 4:15 - Spawn production and Fruiting
- 4:15 - 4:30 - Our mushroom growing facilities
- 4:30 - 4:45 GHP/GAP certification
- 4:45 - 5:00 - Distribution of Grow Bags, Wrap-up

Why are people fungiphobic?

A few mushrooms are very poisonous!!

- Approximately 24,000 mushroom species have been identified [Chang and Miles, 2004]
- About 1000 species (~4%) are known to be edible.
- About 60 of these have been cultivated (about 20 on a large industrial scale)
- But....about 40 species are known to be poisonous!!



Agaricus campestris, yummy!!



Amanita virosa, destroying angel



Amanita phalloides, death cap

Gathering wild specialty mushrooms is a multi-billion\$ industry worldwide!

- Important wild mushroom wholesale markets in the US include Seattle, Portland, San Francisco, Boston



Most wild harvested mushrooms are considered gourmet!!

These are some of the most common wild harvested mushrooms



Morel, \$45/lb



Chanterelle, \$30/lb



Porcini, \$30/lb



Cauliflower mushroom, \$35/lb



White truffle, \$75/lb



Black truffle, \$140/lb

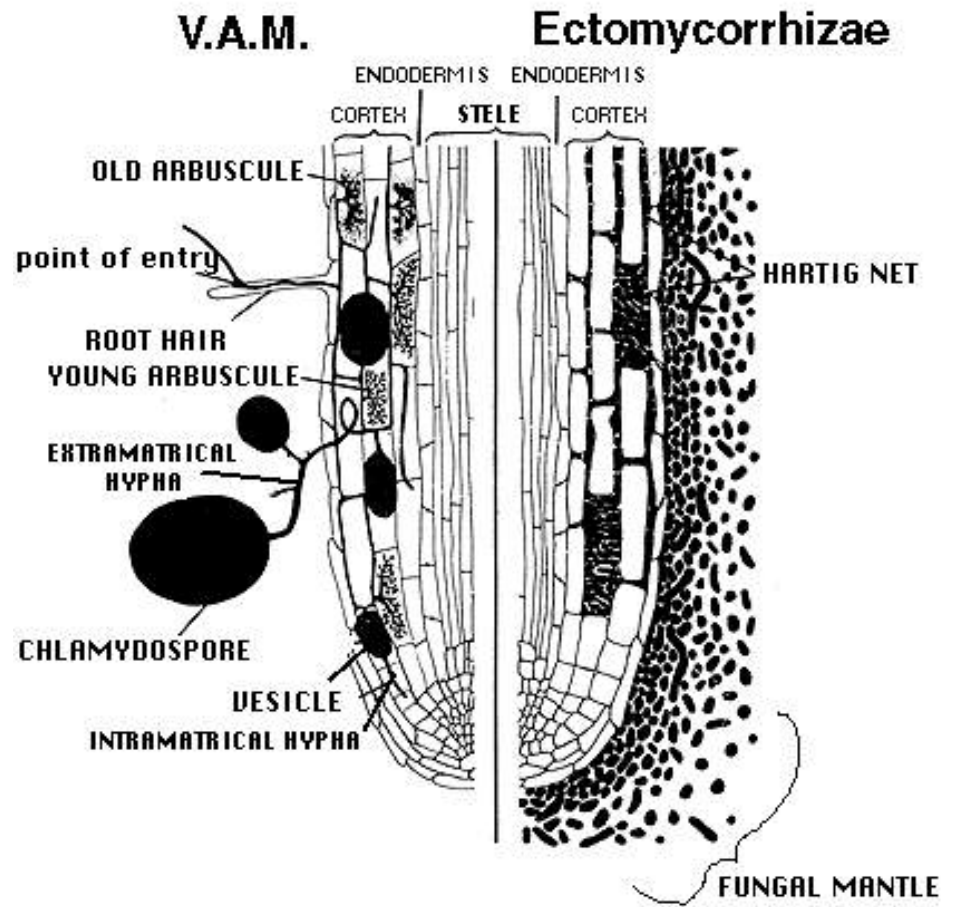
Also visit: <http://www.forestmushrooms.com/guides/wilds.pdf>

Many specialty mushroom cannot be grown in culture and can only be wild harvested. These fungi grow symbiotically with plants in an intimate plant fungal symbiosis- [mycorrhizae fungi](#)

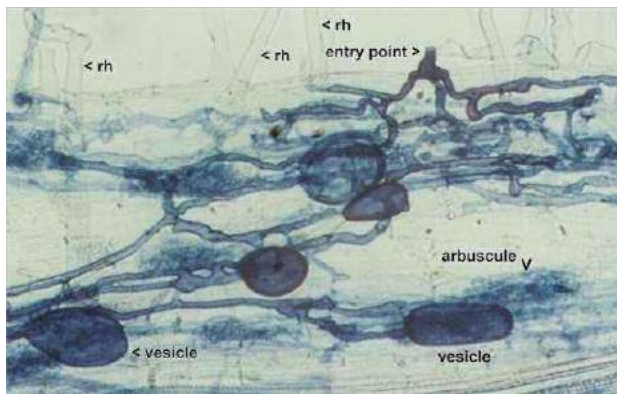
Two main types:

The vesicular-arbuscular mycorrhizae (VAM), known as the **endomycorrhizae**, found inside the plant cell.

The **ectomycorrhizae**, found on the outside of the plant cell

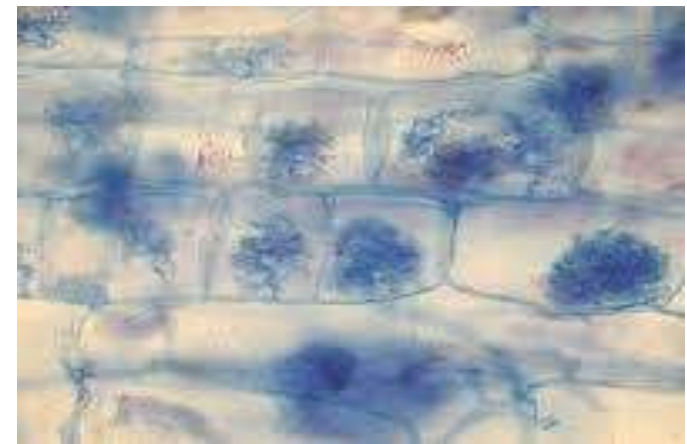


DIAGRAMMATIC REPRESENTATION
OF THE TWO TYPES OF MYCORRHIZAE



vesicles, for storage

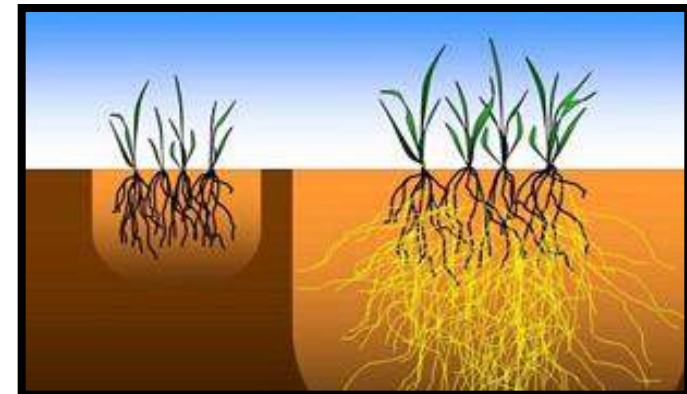
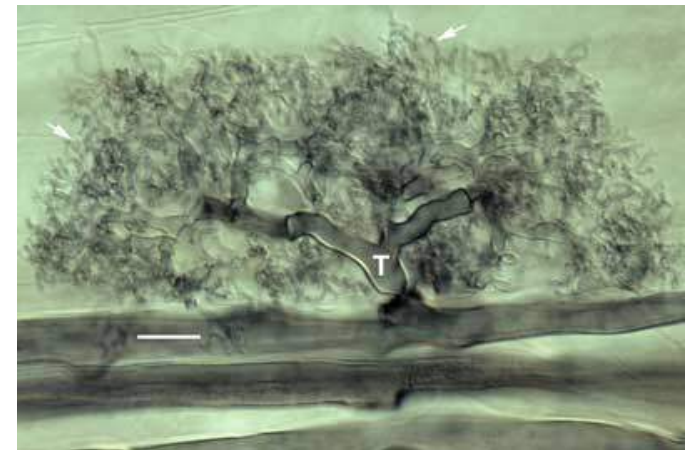
arbuscules, for absorptions



The **obligate symbionts**...the **endomycorrhizal** fungi, known as vesicular arbuscule mycorrhizal fungus (VAM). The **vesicles** are storage compartments and the **arbuscules** are like absorption structures

Endomycorrhizae form critical relationships.

- ~90% of plants associate with mycorrhizae
- The fungus expands the root system of the plant 100-fold!!
- The fungus gives the plant water and minerals (especially phosphorus), and the plants gives the fungus sugars.



Improved plant (and fungal!!) health

- Increased resistance to disease and abiotic stress.
- Increased yield: especially under nutrient limiting conditions
- Roles in global C, P & N cycles are significant.

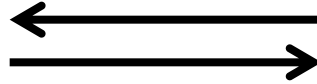


With and without VAM fungi

Note: VAM fungi do not produce mushrooms



Ectomycorrhizal mantle on roots. Note how fuzzy the roots are. This is composed of fungal mycelium



The **opportunists**....the **ectomycorrhizal** fungus.
~ 2% of plant species support ectomycorrhizae

- Mostly associated with woody plants and trees
- Important for tree and forest health.
- Do not penetrate the root cell directly but form an external network called the **mantle**.
- Also gives the plant water and minerals, and the plants gives the fungus sugars.
- Many delicious specialty mushrooms are in this group. Can only be harvested in the wild. Why??



chanterelles



truffles

Modern mushroom production focuses on mushrooms that can grow independently

These are divided into two groups:

1. The field mushrooms, those that grow in soil



Agaricus bisporus
Button mushroom



Agaricus brunnescens
Portobello



Agaricus blazei
Himematsutake

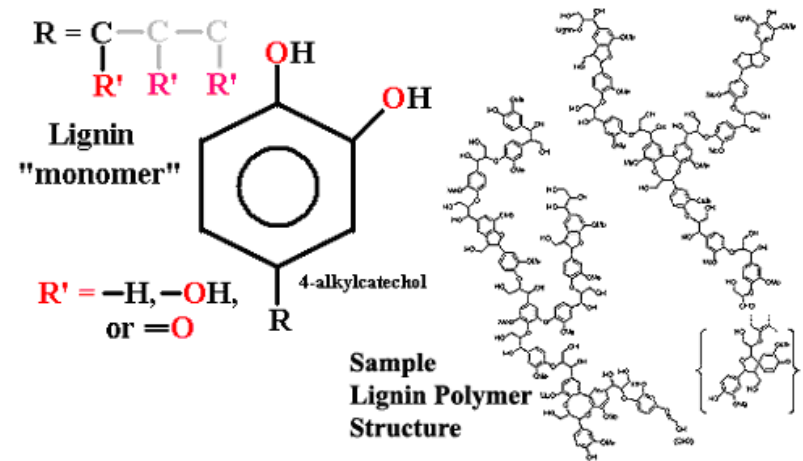


Stropharia rugosoannulata
Wine cap

2. The wood-decay mushrooms, those that grow in and breakdown wood

Lignin is often not degraded, one of the most difficult aromatic compounds to degrade

Some fungi can degrade lignin, referred to as **white rot fungi**, those that can't are **brown rot fungi**. Because brown rot fungi don't perform complete degradation, their efforts help create the thick forest humus that maintains the forest soil structure and help prevent erosion.



White rot, note fibrous pattern of the completely decayed wood

Brown rot, note cube-like pattern of the partially decayed wood



Oyster Mushrooms

Pleurotus spp.



Advantages

- Rapid growth
- Strong competitor (less contamination)
- Many strains with different conditions
- High yielding (BE 150-200%)

Challenges

- Not many
- Short shelf life



Our 4th of July variety pack!

Shiitake

Lentinula edodes

- Perhaps the most popular of all specialty mushrooms
- Has a long history of artificial culture, over 1000 years
- Most cultivation has historically been on natural logs
- Only recently have techniques been developed to allow culture on “artificial logs”



Advantages

- High yields (BE=100-200%, many flushes)
- Long shelf life
- Many strains for different conditions



Challenges

- Not a fast grower
- Requires a second incubation during spawn run to “brown”
- Open bag easy to contaminate



Maitake, hen of the woods

Grifola frondosa



Excellent culinary, nutritional, medicinal properties

Advantages

- Flavorful and nutritious
- Can grow in jar or bag cultured
- Many strains
- Can be used on stumps



Challenges

- Slow grower
- Poor competitor
- Lower yields ($BE = 0.5$)
- Short shelf life



Nameko

Pholiota nameko



One of the most popular cultivated mushrooms in the East

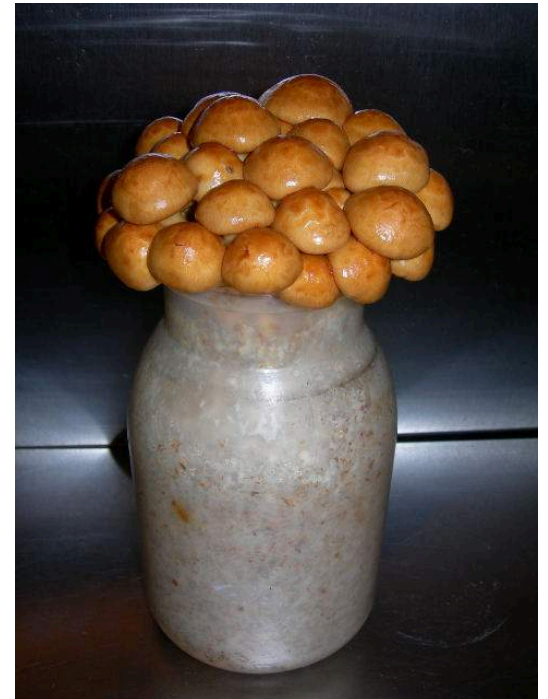
Advantages

- High culinary value
- Easily grows in log, bag, or jar culture



Challenges

- Slow colonizer
- Requires cooler temps and high humidity
- The moist cap requires special handling/packaging



Pioppinno, black poplar

Agrocybe aegerita



High culinary demand

Advantages

- Widespread in nature, many strains available
- Rapid grower
- Attractive product
- Abundant producer (BE = 100-150%)

Challenges

- Few
- Fragile caps, handle with care



Enokitake

Flammulina velutipes



Versatile for culinary purposes

Advantages

- Wonderful product
- High yields (BE = 150%)
- Efficient jar culture

Challenges

- Requires high CO₂ for high quality
- Requires low temps and high H₂O for fruiting
- Fragile caps, special handling/packaging



And then all the medicinals...



lion's mane
Hericium erinacius



chaga
Hericium erinacius



turkey tail
Trametes versicolor



reishi
Ganoderma lucidum



Wood ear
Auricularia polytricha



caterpillarclub
Cordyceps militaris

Who are the larger growers currently producing specialty mushrooms in the West?

Far West Fungi, Moss Landing, CA

<http://www.farwestfungi.com/>

Gourmet Mushrooms Inc, Sebastopol, CA

<https://www.mycopia.com/>

Hotko Kinoko, San Marcos, CA

<http://www.hokto-kinoko.com/>

Fungi Perfecti, Olympia, WA

<http://www.fungi.com/>

Aloha Medicinals

<https://www.alohamedicinals.com/>



Resources and supplies for growers

[Fungi Perfecti](#), Olympia, WA

[Field and Forest Products](#), Peshtigo, WI

[Mushroom Mountain](#), Easley, SC

[Mushroompeople](#), Summertown, TN

[MycoSupply](#), Pittsburgh, PA

[Mushroom Shack](#), Akron, OH



Literature and WEB information resources

Growing Gourmet and Medicinal Mushrooms, Paul Stamet, 1993

Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact, Chang and Miles, 2004 ,

Fungi Treasure: Chinese and American Edible Mushroom Treasures, Mo Mei Chen, 2010

The Mushroom Growers Newsletter

<https://www.mushroomcompany.com/>

The North American Mycological Association

<https://www.namyco.org/>