# Growing Mushrooms for Food and Health

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# Objectives

- Contrast mushrooms and plants
- Describe the life cycle of a mushroom
- Identify the most expensive mushrooms, the most commonly sold in grocery stores, most commonly used medicinally, and the most easily grown at home
- Decide whether and how you want to grow mushrooms

# History of mushrooms

- 5000 BC depicted in cave art
- 3200 BC "Iceman" found in Italian alps carried a bag with 3 different types of mushrooms
- Greek Eleusian mysteries - dreams
- Indian Vedic literature - entheogens
- Traditional Chinese Medicine
- Western Europe – history of murdering Popes using *Amanita* sp.
- Mayan
- Siberian shamans
- Mycophobia – fear of mushrooms


Mushroomstone.com

# What ARE mushrooms?

- Animal
- Plant (vegetable)
- Mineral
- None of the above

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**Mushrooms are neither plant nor animal. They are in their own special kingdom: fungi, along with yeasts and molds.**

**They actually share more DNA with animals than with plants.**

**120,000 known species**

# What makes mushrooms different from plants?

https://oregondiscovery.com/pacific-golden-chanterelle

- **Chitin** in cell walls (also found in exoskeletons of crustaceans and insects as well as fish  scales and butterfly wing scales); structure like cellulose
- **No photosynthesis** (Unlike plants)
- They acquire food by **absorbing dissolved molecules**, usually by **secreting digestive enzymes** into their environment
- Principal **decomposers** and **nutrient recyclers** in biological systems
- Study of fungi = **mycology**

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Historical pearl: "Fungus" comes from Latin, *fungus* (mushroom), which came from Greek *sphongos* (sponge)

# Mushrooms are …

- **Macrofungi** (unlike microscopic fungi, e.g. yeasts)
- Usually just the fleshy, **spore-bearing fruiting body** of a fungus, typically produced above ground or soil or on its food source (such as wood)
- Some are **edible**, some are **medicinal**, some are **poisonous**, some are **psychedelic** or entheogens, and some are inedible, but useful in decomposing, filtering, or serving other functions.
- Today we will focus on **edible**, and some **medicinal**
- We will talk about **growing**, not foraging

*Psilocybe semilanceata* from Wikimedia commons

# Toadstools?


- In German folklore, toads are often seen sitting on "toadstool," capped mushrooms and catching flies that are drawn to some mushrooms.
- This image is of *Amanita muscaria*, or "fly agaric" or "fly amanita" a "toadstool" from fairy tales associated with gnomes
- Also, powdered and added to milk historically to kill flies; DON'T try this at home!
- Kingdom: Fungi
  - Phylum/Division: Basidiomycota
  - Class: Agaricomycetes
  - Order: Agaricales
  - Family: Amanitaceae
  - Genus: Amanita
- Poisonous?
  - Hallucinogenic neurotoxins:
    - Ibotenic acid; muscimol
  - Used as entheogen by Sami people, sub-species
- Images from Wikipedia

# Three basic types of Mushrooms

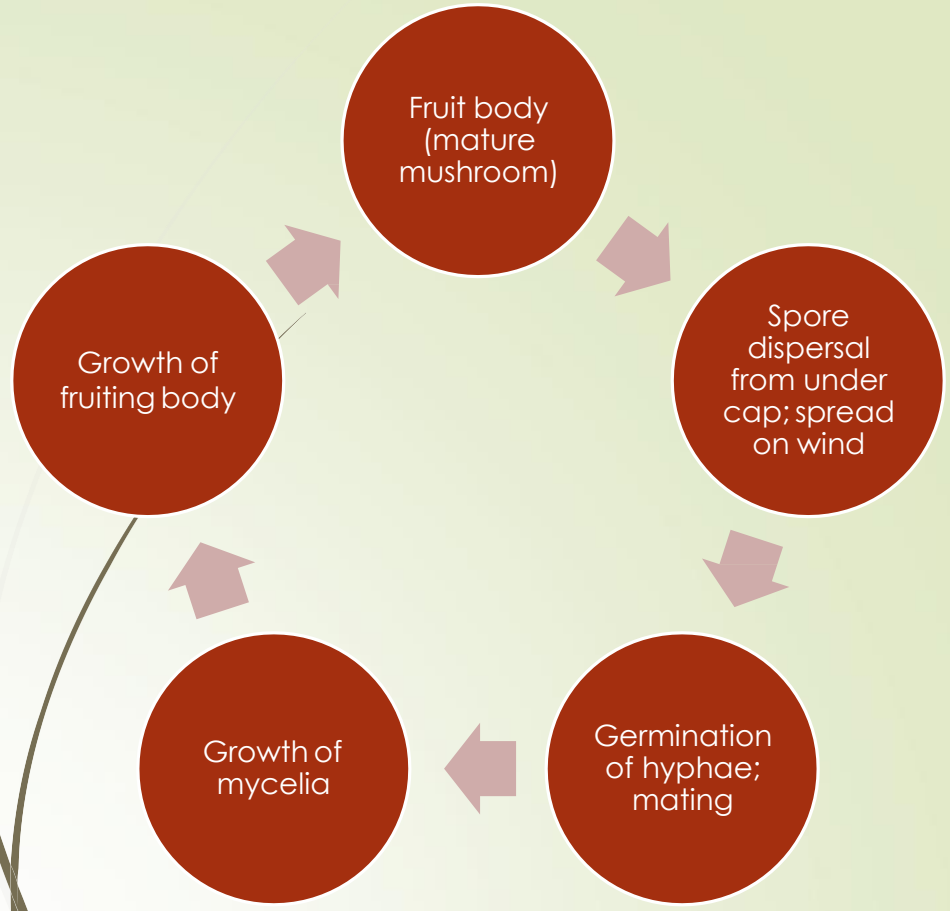
- **Mycorrhizal symbionts** – form mutually beneficial relationship with roots of host plants; the mycelia increase the plant's absorption of minerals and water, and help them resist disease
  - Examples: Matsuke, Boletus, Chanterelles, Truffles
  - Declining in nature due to acid rain and climate change
- **Parasitic** – live off host plant, damaging it
  - Example: Honey mushroom (*Armillaria mellea*) and similar can form very large colonies covering dozens to thousands of acres; *Taxomyces andreanae* lives on Pacific yew and produces Taxol; *Cordyceps subsessilis* is source of Cyclosporin
- **Saprophytic** – decomposers; their enzymes break down lignin and cellulose (Primary – break down wood; secondary – break down compost; tertiary – live in soil; some being used for bioremediation as their enzymes can also break down hydrocarbons, pesticides, PCBs; water filtration
  - Example: Oyster mushrooms; Shiitake; button (*Agaricus brunnescens*)

# Basic principles of growing …

- Understand its optimal natural environment, and replicate that (temperature, humidity, light, host plants/substrate); know its **life cycle**
  - Forest – oyster; shiitake mushrooms
  - Grassland – giant puffball, fairy ring
  - Dung – button mushrooms, "magic" mushrooms (e.g. *Psilocybe*)
  - Compost/litter – shaggy manes
- Many mushrooms are "impossible" to cultivate and humans have learned to cultivate some only in the past 40 years (e.g. morel) while others have been cultivated for hundreds of years

Worthpoint.com

# Life cycle of a mushroom



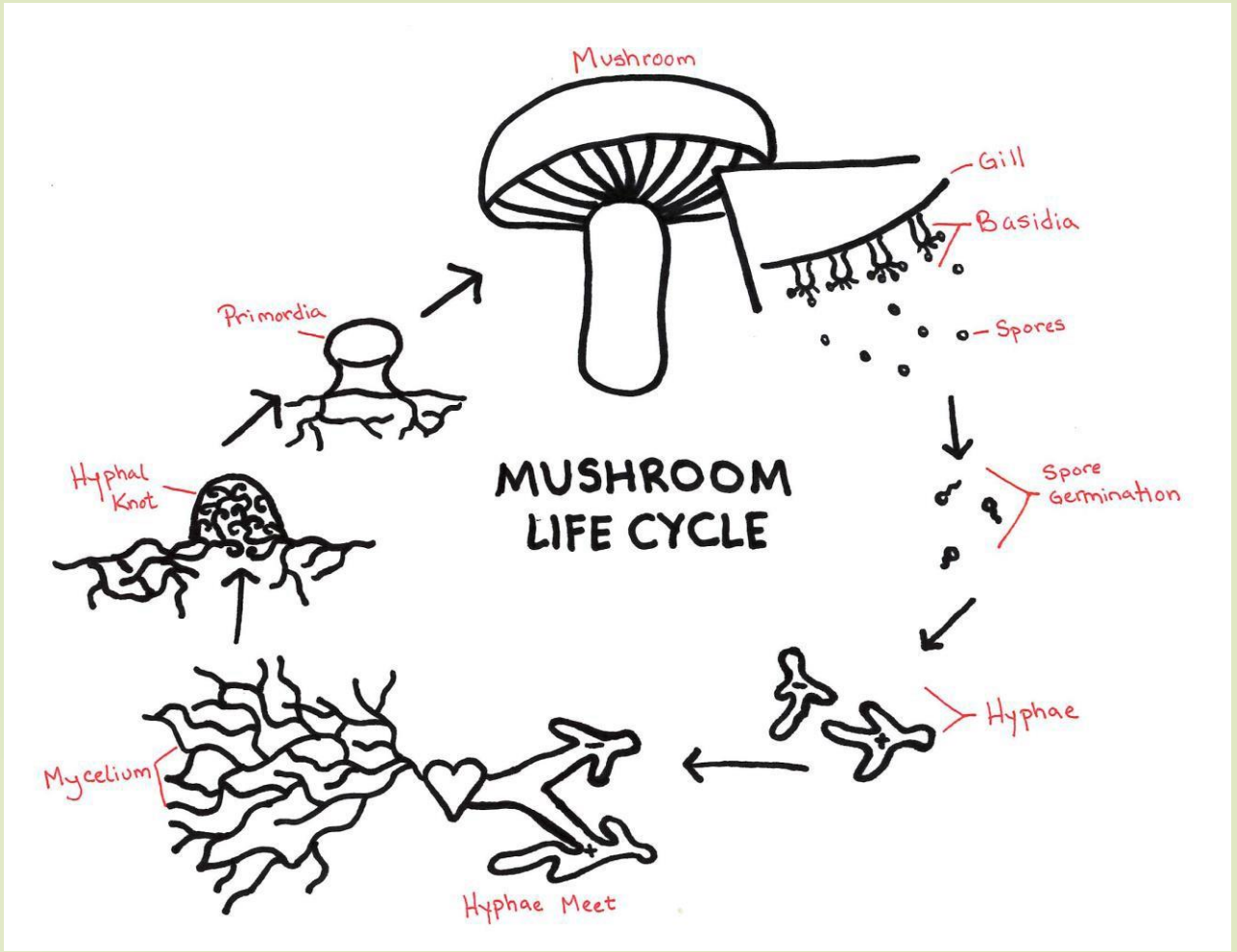




Image from Yellow Elanor

# Fairy rings

- Mushrooms (*Marasmius oreades*) growing in a circle in either open grassy areas or in forests.
- Caused by:
  - Fairies dancing in a ring? Is it bad luck to step into a fairy ring?
  - The body of the fungus (mycelia) is underground, growing outward at up to 8 inches per year, using up soil nutrients and starving grass; when the older mycelia have used up nutrients and start dying, the outer rings send up fruiting bodies to reproduce. They can reach a diameter of 30 feet.

Herbarium.usu.edu

# What is the **most expensive** food by weight?

- Wagyu beef
- Jamon Iberic de bellota (ham from hogs who graze on acorns)
- Almas caviar from albino sturgeon
- Swedish moose cheese
- Alba white truffles (mushrooms)
- Japanese matsutake mushrooms (or mattake)
- Iranian saffron (stigmas of *Crocus sativus*)
- Vanilla beans

Norikko/Shutterstock

# What is the most expensive food by weight?

- Wagyu beef ($200/kg)
- Jamon Iberic de bellota (ham from hogs who graze on acorns) ($700/kg)
- **Almas caviar** from albino sturgeon ($10,000/kg)
- Swedish moose cheese ($1000/kg)
- *Alba white truffles* (mushrooms) ($6000/kg); cannot be cultivated; available only by foraging in select areas
- *Japanese matsutake mushrooms* (or mattake), endangered - $2000/kg
- **Iranian saffron** (stigmas of *Crocus sativus*) ($10,000/kg) – it takes 50,00-75,000 flowers and 40 hours of hand-pick to produce 450 gms.
- Vanilla beans ($400/kg)

Norikko/Shutterstock

# Truffles


| | Black (*Tuber melanosporum*) | White (*Tuber magnatum*) |
|---|---|---|
| aka | French or Perigord truffle | Trifola d'Alba Madonna; Italian truffles |
| Plant symbionts | Holm oaks; French oaks; hazelnut (filbert), cherry | Oak, hazel, poplar, beech |
| Soil pH | 6.5-8; well-drained; poor nutrients | Likely similar; like to grow near streams |
| Harvest | Nov-March | Oct-Dec |
| Natural habitat | Spain, France, Italy; spread by boars and larvae of truffle fly excrement | Italy (Langhe, Motferrat, Alba, Asti, Molise), Bosnia, Herzegovina, Croatia, Slovenia, Hungary |
| Years to grow | If inoculated on 1-year old seedling trees, 5-10 years<br>Markedly decreased production due to climate change | Associated with mature trees of 20-30 years; very difficult to propagate |

Other truffles: Chinese truffle (*Tuber indicum*); less expensive, sometimes fraudulently sold as Black truffles; summer truffle (*Tuber aestivum*); winter truffle (*Tuber brumale*)

# What are the most common mushroom we purchase at the grocery store?

- White and button mushroom, *Agaricus bisporus*
- Crimini (baby bellas) –young Portabello
- Portabello mushroom
- Shiitake mushroom (black or oak forest)
- Maitake (hen of the wood)
- Oyster (angel wing; common for kits)
- Enoki (futu or winter)
- Black trumpet (black chanterelle)
- Chanterelle (golden)
- Morel – mostly wild
- Porcini (Cepe, bolete)- wild

- COOK before eating to break down toxic constituents; many contain low-grade carcinogens and difficult to digest compounds

Photo by Chelsea Kyle for Epicurious

# Dr. Andrew Weil's favorite Medicinal Mushrooms

- **Shiitake**; lower cholesterol, have antiviral and anticancer effects
- **Cordyceps**; used in Chinese medicine as a tonic and restorative and to improve athletic performance
- **Enoki**, can be eaten very lightly cooked; immune-enhancing
- **Maitake** (hen of the woods) – anticancer, antiviral, immune-enhancing, blood pressure lowering
- **Reishi** (medicinal only; hard, woody); improve immunity; anti-cancer; anti-inflammatory, liver protector; reduces allergies
- **Lion's mane**; improve nerve growth and cognitive function
- **Turkey tail** (medicinal only) anticancer effects

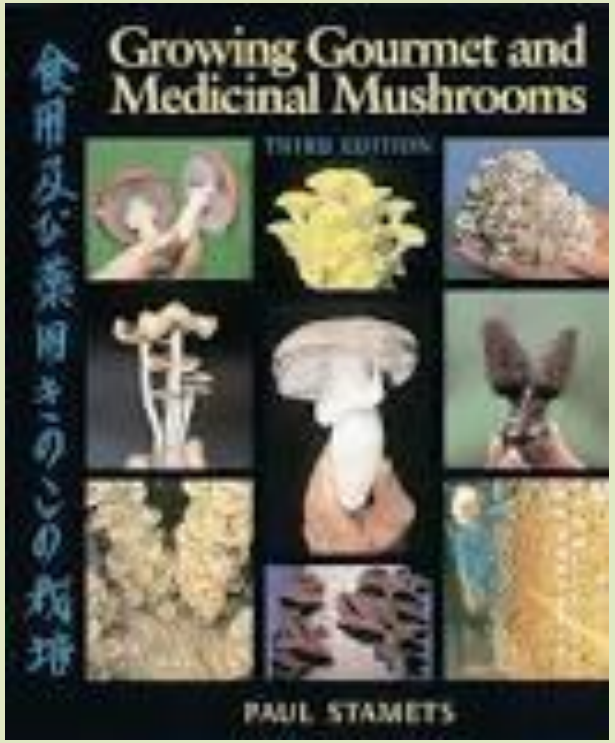
James Mahan/Getty images/iStockphoto

# Terminology

- Plants. We **plant** seeds in fertile **soil**.
- Mushrooms. We **inoculate** a **substrate**.

- For both, we try to reduce competitors
  - Plants vs. weeds, fungus, bacteria, viruses, insects, animals
  - Mushrooms vs other mushrooms, molds, bacteria, insects

- This is why we grow many mushrooms on a sterile substrate – to decrease competition and disease



# 1. Kits: Easiest way to start


- I started by ordering an oyster mushroom kit from Amazon
- Cost: $20- $30
- Process:
  - 1. order kit
  - 2. open box
  - 3. wash hands
  - 4. cut flaps in plastic case
  - 5. soak in water for 6-12 hours
  - 6. water once daily
  - 7. Once you see pins in 1-2 weeks, mist twice daily
  - 8. Harvest in about two weeks
- Problem: how to know when to harvest a mushroom you don't know well? I waited too long, and they rotted.

https://d2y5sgsy8bbmb8.cloudfront.net/v2/f1dfcef4-f86e-506d-9077-360ffbdf8f2b/ShortForm-Generic-480p-16-9-1409173089793-rpcbe5.mp4

# 1b. Kits continued

- How to grow shiitake mushrooms from a Fungi Perfecti kit (plastic bag)
- May need to refrigerate the kit for 3-5 days if it the kit arrives without the baby mushrooms pinning.
- Soak in de-chlorinated water for 2-4 hours
- Set in cool place with indirect light.
- https://www.youtube.com/watch?v=BNHbMpsiG6I from Kevin at Epic Gardening (10 minutes)


Cascadianmushrooms.com

# 2. Grow your own: plug spawn

National supplier: Fungi perfecti (http://fungi.com) Paul Stamets, Olympia Washington

Order plug spawn and sealing wax (beeswax or edible soy wax)

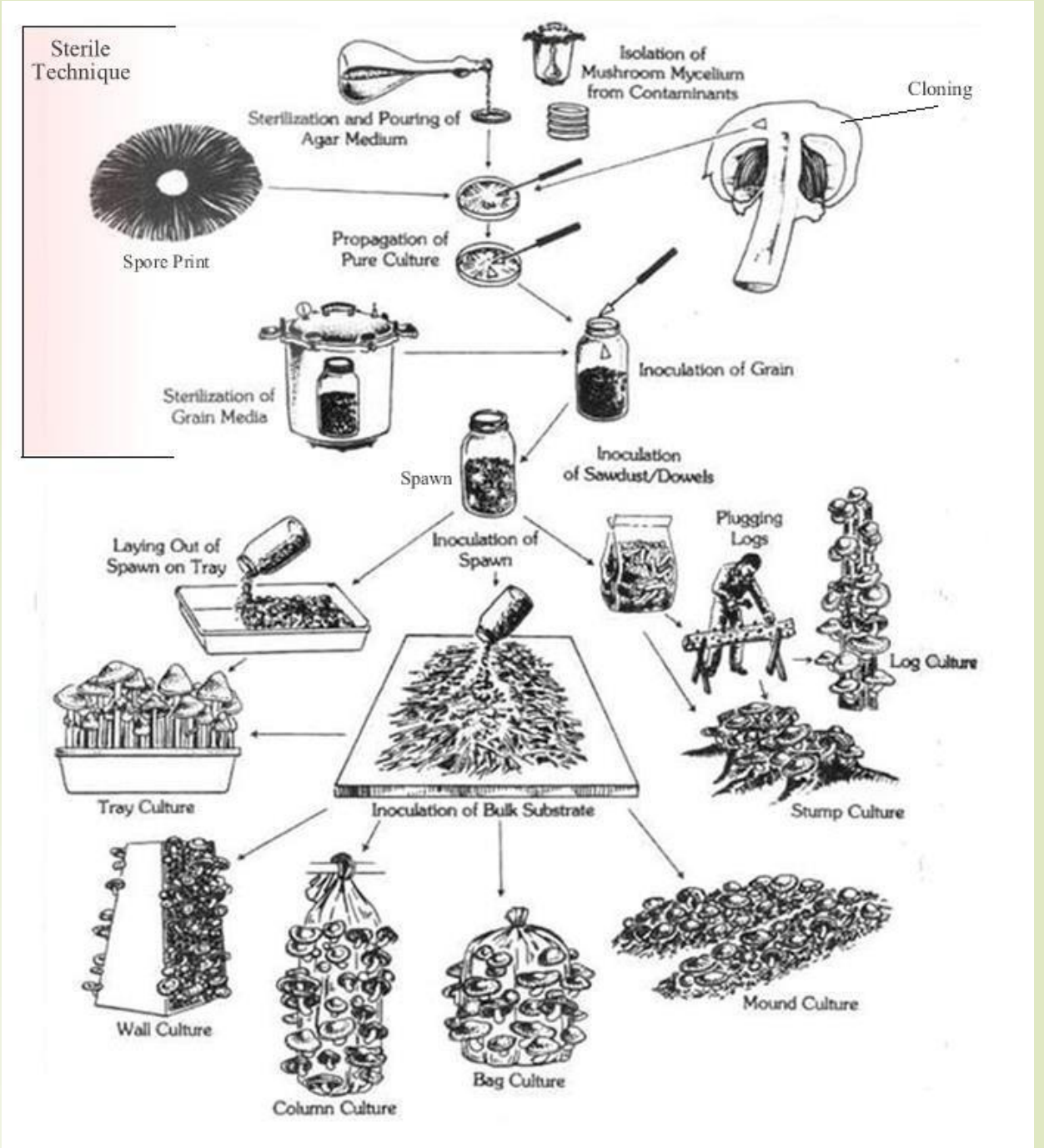
Typical amounts: 100 – 1000 plugs ($15-$50)

You'll also need a 4-6 inch diameter oak or other hardwood log, a drill, a hammer or rubber mallet, sealing wax, heat source to melt wax; brush to brush on wax; a label; a shady place; water; patience (it takes 6-12 months to grow to harvest shiitake)

Local supplier: Swainway Urban Farm (Clintonville) swainwdy.com

How to videos:

- https://www.youtube.com/watch?v=StIMkRDx_MU (organic gardener) (4 minutes)
- https://www.youtube.com/watch?v=kCbWaFh0kzg (garden fork) (10 minutes)




Feeling adventurous?

Try growing from scratch…

Stamets P. p.80 Growing Gourmet and Medicinal Mushrooms

# 3. **Collect your own spores** and/or mycelia, and make your own substrate

1. Select a gilled mushroom
2. Cut the stem with a clean knife at the highest point without touching the gills.
3. Place mushroom cap on clean piece of paper or glass, covered with a clean bowl for 24 hours.
4. Remove mushroom cap.
5. Store paper or glass in ziplock bag or another piece of glass
6. Grow in agar; then transfer to grain spawn

Milkwood permaculture

# Alternatively, make a spore slurry

- Select several mushroom caps
- Immerse in 5-gallon bucket of clean, de-chlorinated water with 1/2 tsp salt (to inhibit bacteria) and 50 ml molasses
- Let sit for 4 hours
- Remove mushrooms
- Allow the mushroom "broth" to rest for 24-48 hours at 50-80 degrees F
- Grow in agar (spores -> mycelia)
- Pour or inject into grain; let mycelia grow; inoculate substrate

# Potential substrates: match to mushroom preference

- Wood waste; sawdust; chips, especially from hardwood (not pine, cedar, redwood)
- Rye or wheat straw
- Recycled paper or cardboard
- Coffee grounds
- Corncobs
- Seed hulls
- Nut hulls
- Soybean meal

Sterilize?


Funguys.co.za

# Supplements to substrate

- Cornmeal
- Cottonseed meal
- Oat,wheat, or rice bran or flour
- Rye berries
- Spent grains from beer fermentation

- Sterilize?
- OR purchase substrate mix/supplement

Etsy.com

# Putting it together

- Soak the sterilized substrate/supplement
- Inoculate with spores/spawn
- Keep at correct temperature/humidity
- Be patient
- Harvest

- Often after first harvest, continued care can yield additional fruiting
- When finished, put substrate in compost

Fungicultura.wordpress.com

# Top 11 Kits according to 2018 GardenersPath.com Leslie M.G.

- Enoki. Pro-Gro kits from Mushroom Mojo
- Lion's Mane. Gallboys via Amazon or Mushroom Mojo via True Leaf Market
- Morel. GMHP Gourmet Mushroom Products (raised bed outdoors; perennial)
- Black oyster. Direct Gardening
- Pearl oyster. Back to the Roots Organic Kit
- White oyster. Direct Gardening
- Reishi. Gallboys via Amazon
- Shiitake. 2funguys.com (pre-inoculated logs)

# Resources

- Books
  - Cotter T. Organic Mushroom Farming and Mycoremediation
  - Laessoe T. Del Conte A. Lincoff G. The Mushroom Book. DK. 1996
  - Peterson LA. Edible Wild Plants of Eastern and Central North America. Peterson Field Guide 1977
  - Rhodes LH, et al. Mushrooms and Macrofungi or Ohio and Midwestern States; A Resource Handbook. OSU , 2013 – lots of photos; helpful for identifying edible vs. poisonous mushrooms growing in Ohio
  - Stamets, Paul. Several books. Growing Gourmet and Medicinal Mushrooms. 3rd edition, 2000. Mycelium Running: How Mushrooms Can Help Save the World. 2005
- Extension handouts
  - Penn State: Oyster Mushroom Fact sheet, https://extension.psu.edu/cultivation-of-oyster-mushrooms
  - Cornell Shiitake growing: https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/d/958/files/2014/03/Shiitake-BMP-3-11-1osfnxs.pdf x

# Resources, continued

- Websites
  - Fungimag.com
  - iNaturalist
  - Mushroom Observer
  - North Spore (www.northspore.com – sells mushroom grow kits, spawn, supplies, recommended by Erika Lyon)
  - Oyster Mushroom cultivation, https://fungially.com/wp-content/uploads/2015/11/FungiAlly_Free-Oyster-Mushroom-Cultivation-Book-1.pdf
- Local grower: Joe Swain (joseph@swainway.com)
- Local expert: Erika Lyon, OSU Extension, Jefferson County (lyon.194@osu.edu; 740-461-6136)

# Questions?