Shannon ABC
applied biotechnology centre

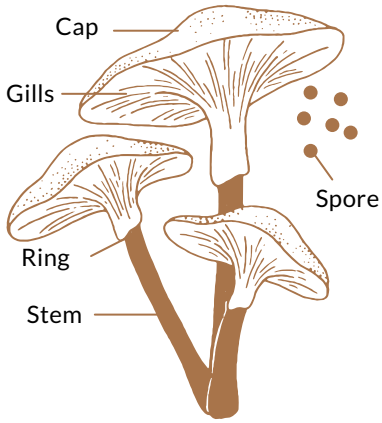
GROW YOUR OWN MUSHROOMS

by Maria Nipo

Mushrooms

Mushrooms are not only nutritious, but also a way of decomposing agricultural waste and generating wealth. Mushrooms are a rich source of carbohydrates and protein, having all the essential amino-acids. They are sources of vitamin D and selenium, helping the immune system function properly. Furthermore, the waste of mushroom production, known as spent mushroom substrate is also reported to improve soil health. The very fact that mushrooms can be cultivated on agricultural wastes, reducing the gas emissions related to the burning of the waste, is sufficient reason to grow mushrooms. Moreover, the implementation of circular economies brings economic value for the mushroom production since waste materials can be used as raw materials.

Mushrooms (sporophore) are the fruit bodies of several species of macrofungi, typically from the phylum Basidiomycota and Ascomycota. These structures with an umbrella shape produce spores in lamellae underneath the pileus (gills), the spores for these two groups are located in a special structure called basidium (for basidiomycetes) or ascus (for ascomycetes).



What will you need?

- Big plastic box
- Ethanol 70%
- Sterile scalpels
- Pressure cooker
- Glass container (jar)
- Sterile petri dishes
- UV light Box
- Glass flasks with filter
- Sterile plastic bags with filter
- Agar
- Potato flakes
- Dextrose
- Mushroom
- Grain (Spawn)
- Substrate (straw, wood pellets, manure,...)

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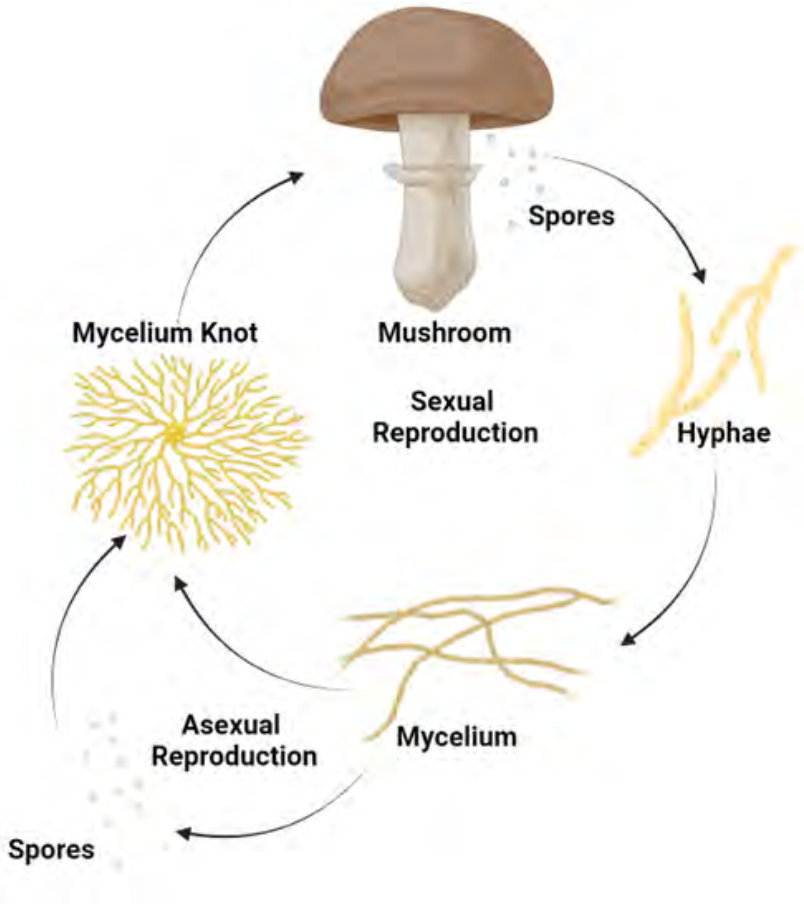
Mushroom Life Cycle

The mushroom life cycle depends on the type of mushroom grown as well as the environment which the mushroom experiences. Small mushrooms can grow in about 1 day, while medium to larger sized mushrooms can grow in about 3-7 days.

The mushroom cycle starts with the release of spores from the gills underneath the mushroom. When conditions are optimum the spore will germinate (like seeds), dividing by mitosis, to produce a thread like fibre, called the hyphae, that can either be female or male. When the hyphae of the opposite sex meet and combine, a mycelium starts to grow.



The mycelium is the web-like root system that remains rooted to the ground and metabolizes all the nutrients for the mushroom growth. So, it is the vegetative part of a fungus, consisting of a mass of branching, thread-like hyphae. When the right conditions for its growth are met, such as the temperature, moisture in the soil and the nutrients, the mycelium will continue to expand. Mycelium is considered one of the biggest leaving organisms in the world, since they can cover a huge area underneath the soil.

When two hyphae meet and form the mycelium, they wind themselves around forming a hyphal knot, it looks like a tiny white pigment in the middle of the substrate, that will soon develop into a grown mushroom. The mushroom releases the spores and the cycle begins again. This represents the sexual cycle of the mushrooms, however they can also reproduce through asexual cycle, where the mycelium releases spores instead of the fruiting body. This process is the one used to isolate and grow mushrooms at home more easily. A part of sterile mycelium material can be collected from inside the mushroom and isolated in potato dextrose agar (PDA) petri dishes (see below how to make PDA).

Isolation and growth

Taking advantage of the asexual cycle of mushrooms, allows for the isolation of mycelium in petri dishes. This mycelium is then transferred to grain (wheat, rye, brown rice, white rice, wild bird seed and even popcorn) and allow the mycelium to colonize the whole grain; this is called spawn. The colonized grain (spawn) can be transferred to a specific substrate (coffee ground, straw, coco coir and vermiculite, hardwood pellets, manure, logs, cardboard, sawdust) inside sterile plastic bags and, given the right conditions, mushrooms will grow after colonization of the substrate. Fruitification occurs after exposure of mycelium to oxygen, high humidity, low level light and cooler temperatures, mimicking conditions in nature.

Step 1: Plate inoculation | Step 2: Spawn inoculation | Step 3: Substrate inoculation and colonization | Step 4: Fruitification and harvest

Mushroom grow relies on 4 steps:

1. Plate inoculation: isolation of the mushroom mycelium in petri dishes filled with potato dextrose agar (PDA).

A)Preparation of potato dextrose agar (PDA)

1. Boil 200 g of sliced unpeeled potatoes in 1 liter of water for 30 minutes.
2. Filter through cheesecloth, saving effluent, which is potato infusion.
3. Add 20g of dextrose and 15g of agar to effluent. Boil to dissolve completely.
4. Sterilize media by autoclaving at 121°C for 15 minutes in glass jars (it takes 1h30 to successfully sterilize the media in a pressure cooker at home).
5. Aseptically dispense into sterile Petri dishes (this can be done using a transparent box turned upside down on a bench, see picture) and let agar cool and solidify.

B) Mushroom isolation

1. Isolate a piece of the interior of the mushroom on the centre of the plate.
2. If contaminations are visible after a few days, continue to transfer pieces of mycelium from one petri dish to a clean one, and let it grow.

NOTE: You can also prepare liquid cultures from mushroom, using the same process. However, instead of plating the mushroom piece, suspend it the same media without agar in glass jars or bottles. Shake often to keep nutrients accessible to the mycelium, with a syringe you can transfer the culture to the spawn.

2. Spawn inoculation: transfer of isolated mycelium from PDA plates to pasteurized grain (check page 5 on how to pasteurize grain and substrate). This step is important to amplify the distribution of mycelium on the substrate.

1. Transfer pieces of colonized agar to sterilized/pasteurized grain (different types of grain can be used, such as popcorn, bird feeding).
2. Let in the dark until all spawn is colonized.

3. Substrate inoculation and colonization: Inoculation of substrate with colonized grain

1. In a sterile environment mix 1:10 spawn and substrate in plastic bags with filter.
2. Let substrate in the dark for 2 weeks until substrate is colonized

4. Fruitification and harvest:

1. Change environmental conditions to trigger mushroom growth.
2. After 4-7 days harvest.
3. Repeat 2 weeks in the dark and harvest again after 1 week.

Conditions step 2 and 3

Tem. ºC around 24ºC (will vary with the species)
Humidity 60%
No light or fresh air

Conditions step 4

Tem. ºC around 20ºC (will vary with the species)
Humidity >85%
Light and fresh air (open holes)

Choosing the right substrate

A good substrate is rich in fibrous materials like lignin, cellulose and hemicellulose., source of energy for the growing mycelium. Here are a few important things to keep in mind when choosing a substrate:

1. It needs to have 1 to 2 percent (N) nitrogen. Substrates such as sawdust or straw need the addition of manure or other materials to achieve these requirements.
2. Needs to contain trace amounts of minerals such as (Mg) magnesium, (K) potassium, (Ca) calcium, (S) sulphur and (P) phosphorus.
3. Needs to be slightly acidic, with a pH level of about 5 – 6.5.
4. Needs a moisture content of 50-70%.
5. Finally, your substrate needs to be pasteurized or autoclaved (pressure cooker) to make sure there are no competing organisms.
6. Finally, needs to have good porosity to enable air exchange, for the mycelium to colonize well.

Usually used substrates

- Peat
- Sawdust
- Straw
- Wood pellets
- Coconut coir
- Manure
- Logs
- Coffee grounds
- Vermiculite
- Cardboard

The reuse of the organic waste as a substrate for mushroom cultivation is one of the promising approaches to reduce natural resources dependency and meet the European circular economy goals.

Species of mushroom and type of substrate

Different species of mushrooms have different substrate preferences due to their different nutritional requirements.

Mushroom species		Type of substrate
Pearl Oyster (*Pleurotus ostreatus*)		wheat straw, paddy straw, corn cobs, saw dust, cotton hulls, coffee ground, coconut coir, vermiculite, Wood pellets, sawdust, logs
Blue Oyster (*Pleurotus ostreatus columbinus)*		
Golden Oyster (*Pleurotus citrinopileatus*)		
Pink Oyster (*Pleurotus djamor*)		
Phoenix Oyster (*Pleurotus pulmonarius*)		
King Oyster (*Pleurotus tuber-regium*)		
Shiitake (*Lentinula edodes*)		Wood pellets, sawdust, logs
Wine Cap (*Stropharia rugosoannulata*)		
Lion's Mane (*Hericium erinaceus*)		
Enoki (*Flammulina velutipes*)		
Maitake (*Grifola frondosa*)		
Button mushroom (*Agaricus bisporus)*		Composted manure, peat, straw

How to pasteurize/sterilize your grain/substrate

Pasteurization is the process of heating up a substrate between 70-100°C for a period of 1h30 to 3 h. It doesn't remove all the microorganisms, but it will reduce their overall population giving the mushroom species a head start to colonize de substrate. Pasteurization is an economic method for substrate sterilization before inoculation of grown spawn, it relies on the heating of the substrate with boiling water.

Steam sterilization is used to sterilize objects that are capable of withstanding extreme heat (121°C–140°C) and pressures of about 15 psi. This type of sterilization can be achieved at home using a pressure cooker, it is ideal to sterilize the grain before spawn inoculation (check step 2 pf isolation and growth). Since it is more efficient in destroying populations of microorganisms it will reduce the contamination of spawn prior to inoculation of the substrate.

NOTE: Before sterilizing your grain, leave it soaking for at least 24h to retain moisture needed for mycelium development.

Health benefits of mushrooms

Mushrooms produce a range of structural or secondary metabolites that exhibit heath benefits to humans. They can be from the classes of polysaccharides (e.g., b-glucans), proteins or phenolic compounds, terpenes, and steroids.

The medicinal properties of mushrooms have been reported to include:

Antibacterial	Antioxidant	Antidiabetic	Immunomodulatory
Antifungal	Anti-inflammatory	Antiangiogenic	Antiviral

Some species of mushrooms with reported medicinal properties

Auricularia auricula	*Morchella esculenta*	*Coprinus comatus*	*Ganoderma lucidum*	*Hericium erinaceus*
				

Shannon ABC has helped many companies to find opportunities in their by-products, adhering and helping with the transition to a circular economy model, leading to product valorisation and commercial opportunities.

Contact us for more information :

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