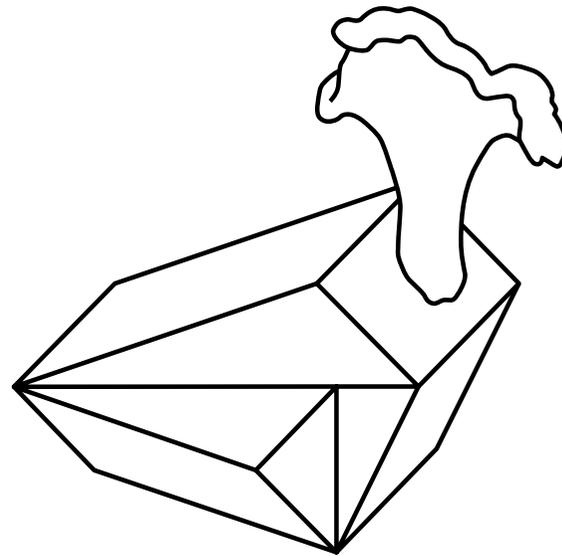


# Introduction to fungi



## Legend

### **Mushrooms**

If there is a mushroom growers term in the text which you need to understand, it is marked in a yellow border. Check the **glossary** for reference.

### **Mushrooms**

Instructions and practical steps are marked with a yellow background. Here you need to get your hands on and do something.

## Glossary

This is a basic collection of terms you should be familiar with as a mushroom grower.

**clean** free from any contamination.

**Cellulose** A compound in all organic materials. Cellulose can't be digested by humans, it is the main constituent of cell wall of green plants.

**colonization** see vegetative growth.

**contamination** a pathogen polluting and spoiling a substrate.

**flush** the moment when many fruiting bodies start developing at the same time.

**fruiting** see reproductive growth.

**fungi** a spore-producing organisms, feeding on organic matter.

**inoculation** initiating vegetative growth by transferring spawn into a substrate.

**Lignin** Lignin is indigestible by all animals, like Cellulose it is part of cell walls of green plants. It can only be degraded by fungi.

**microorganism** microscopic organisms which are abundantly present in the air, especially bacteria, viruses or fungi.

**mushroom** common name for the reproductive body of fungi. Mushrooms are the fruiting bodies produced by mycelium.

**mycelium** network of filaments that form the vegetative body of a fungus.

**pathogen** a microorganism that can

potentially cause contamination. **reproductive stage** the fungus enters its reproductive stage and forms fruiting bodies. Also called fruiting.

**spawn** mycelium seeds, used to initiate spawn run.

**spawn run** see vegetative growth.

**sterile** free from living microorganisms, totally clean.

**substrate** the organic material on which the fungus grows and from which it obtains its nourishment.

**vegetative stage** mycelial growth throughout the substrate, after spawning. The fungus establishing itself against competitors and collecting nutrients. Also called colonization or spawn run.



**glos  
sary**

## Introduction to fungi

There lies a big potential in **mushrooms**, which is widely unknown. This is an instruction to mushroom cultivation. It introduces the organism and enables you to make use of it for your own purpose.

It addresses designers, engineers, farmers as well as non-professionals. By understanding mushroom cultivation, you will be able to include the organism into your thinking and implement it in projects and applications.

[goo.gl/kwkFwh](http://goo.gl/kwkFwh)

## How it works

This introduction to fungi leads you through the whole process of mushroom cultivation, with **day-to-day** instructions. It is a step-by-step guide, leading you through the process of mushroom cultivation, day by day. Every day you get some additional information and you learn, what are the next steps and how to proceed. It provides you with all the steps you need to do and offers starting points for personal interests and individual research. It will broaden your understanding of fungi on a daily basis, enabling you to reproduce and use them. Use the cards day by day, counting from today, to be guided step-by-step through the process, starting with **day 1**.

## List of necessities

Before you can start, make sure that you have all the necessary tools and materials. On this page you find a list of possible suppliers.

**Start collecting used coffee grounds from your coffee machine or a nearby café and store it in the fridge, you will need it soon.**

**Oyster mushroom spawn (*Pleurotus Ostreatus*)**

**Sawdust**

**Wood chips**

**Wheat bran**

**Used coffee grounds**

**Gypsum**

**Disinfectant: Hydrogen Peroxide (3%) or Isopropanol (70%)**

**Gloves**

**Spray bottle**

**Filter-bags / filter-boxes / filter-jars**

**Empty laundry bag**

## Spawn supplier

[gluckspilze.com](http://gluckspilze.com)

[gombacsira.hu](http://gombacsira.hu)

[pilzzuchtshop.eu](http://pilzzuchtshop.eu)

[pilzbrut.de](http://pilzbrut.de)

## Material supplier

[gluckspilze.com](http://gluckspilze.com)

[pilzzuchtshop.eu](http://pilzzuchtshop.eu)

**Fressnapf, dm, Obi (and other)**

**Local farmers or wood workshops**

**Local cafés and restaurants**

**pharmacies**



**pre  
face**



## Before you get started

Make sure you will be able to care for your mushrooms during the next 23 days. Especially **days 1–3** as well as **days 16–22** require your presence and attention. Try to plan the start of your cultivation. If you can't be available all the time, instruct someone to continue with the steps on your behalf.

## Substrate recipe

You can grow Oyster mushrooms on any organic **substrate**. There is room for experimentation here.

The following basic recipe has proven to work well and to create a good yield. It is a base recipe, working for most edible and medicinal mushroom (except of button mushrooms or psilocybin-containing species).

## For 1 liter of substrate you need

**400ml sawdust**  
**200ml wood chips**  
**200ml fresh coffee grounds**  
**50ml wheat bran**  
**25ml gypsum / plaster**

## Prepare the substrate

You can scale the amounts of the recipe as you like.

**Soak the wood chips and the sawdust in water over night.**  
**Use a laundry bag to keep the materials together while soaking.**

## Prepare the filter container

Preferably work with containers or bags with a micro-filter. You can make your own DIY filter-containers, using clean jars.

**Punch a hole in the lid with a nail and firmly stuff it with cotton wool as a filter.**

That is a good way to reuse your waste glass containers and it works as well as a industrially produced filter-container.



**day**  
**1**



## Working clean

Mushrooms are competing for nutrients with other **microorganisms** like bacteria and molds. These can possibly slow down your mushroom's growth, overpower them and produce harmful spores. To prevent these things from happening, you need to keep the working environment as **clean** as possible.

## Clean yourself

The following is what you should do every time you get your hands on or interact with the mushrooms. It is important and should be followed carefully.

**Put on clean clothes, clean your hands with soap, work on a clean table, put on gloves. Disinfect all surfaces and your hands with Hydrogen Peroxide or Isopropanol. Let it dry off for 30 seconds, this is the time it needs to make all surfaces **sterile**.**

**From that point on, don't touch possibly contaminated or dirty things any more, eventually repeat disinfection.**

## Prepare the substrate

**After soaking for one night, squeeze out the material as much as possible.** When you compress a hand full, it should not drain anymore but softly stick together. This is then the right level of moisture. Oyster mushrooms contain of 90% water,

so it is important to provide the substrate with the right amount of moisture, although too much may spoil the mushroom and allow **pathogens** to grow).

**Add wheat bran, coffee grounds and gypsum to the bag, close it and mix it very well with your hands. Eventually adjust the moisture with some extra sawdust or water.**

## Spawn inoculation

**Inoculation** is the process of introducing **spawn** to a substrate and initiating **spawn run**. Spawn is considered the mushroom seed.

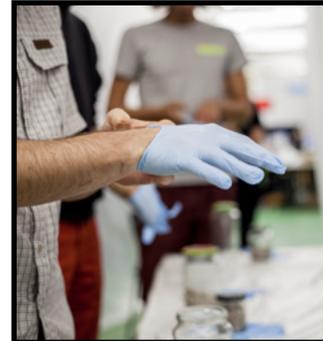
**Prepare a clean filter-container. Add spawn to the prepared substrate, layer by layer, starting and ending with a layer of spawn. Make sure to break down big junks. Fill it to about one centimeter below the top. In total you should not use more spawn than 10% of the substrate.**

Take care that there is no substrate sticking to the upper edges of the container before closing the lid.

**Now place it in a dark place and continue tomorrow.**



day  
2



## Spawn run

Spawn run is the process of the mushroom establishing itself against competitors and securing its territory. This is the **vegetative growth** of the mushroom, during which **mycelium**, a tiny web of filaments, is growing throughout the substrate. Mycelium is the main body of the mushroom – naturally growing underground – which produces aggressive enzymes to break down organics and take in nutrients. In nature, spawn run happens underground.

## Set up the environment

Your organism is now inoculated and started spawn run. During that time it needs specific environmental factors like temperature and darkness, which you need to take care of.

**Place the container in a dark place with temperatures around 25°C, ±5°C. The mycelium doesn't like to be disturbed during spawn run, so don't open it and don't move it too much.**

Between **day 4** and **day 5** you should be able to see first mycelial filaments growing out of the spawn, looking like tiny strings. Depending on the environmental factors, spawn run will take **10–20 days**.

## Monitor

Things can possibly go wrong during mushroom cultivation. Spawn run is a critical time when **contamination** can appear, which could fail the whole cultivation process.

**It is important to monitor what is going on inside of the box, to be able to react in time eventually. You need to check for green and yellow spots – contamination – on a daily basis.**

If everything goes well you should see the mycelium growing out of the spawn, spreading across the whole substrate and creating a fluffy white surface in the end.

[goo.gl/KA152g](https://goo.gl/KA152g)



day  
3



## Contamination

Millions of pathogens are flourishing in the nutritious substrate. Every single of these microorganisms has the potential to spoil the whole substrate and to end all of your efforts.

This is why you work with a very strong and fast growing mushroom species – Oyster mushrooms. Once the mushroom has covered the substrate, it is very unlikely to spoil. That means, the faster and the more aggressive the mushroom grows through the substrate, the better.

## Hygiene

We can only take preventive measures, being hygienic is the most effective one. The cleaner you work, the better. Therefore follow the steps from **day 2** and clean yourself.

## Non-sterile work

Non-sterile work with Oyster mushrooms has a relative high rate of success. Still, keep in mind, as you are working with living organisms and very complex biological processes, there is no 100% success rate. Even skilled and experienced mushroom growers can't completely prevent contamination.

## Troubleshooting during spawn run

If green, blue, yellow or gray colored spots start to appear on the substrate, this is a contaminant.

**You need to cut off the contaminated part and treat the spot with Hydrogen Peroxide. If the contamination comes back or spreads, you need to isolate and eventually dump it, as it might produce harmful spores.**

If spawn run only happens on the top half of the substrate, this indicates that the substrate is too wet. The moisture might attract pathogens and prevents the fungi from growing.

**Spill the excess fluid and monitor if spawn run continues without contamination.**

If there is no growth at all, the spawn might have been too old or the substrate too dry. In that case, check **appendix** on how to proceed.



day  
4



## Oyster mushrooms

Oyster mushrooms (Latin name: *Pleurotus Ostreatus*) are one of the most popular edible mushrooms. They can be found almost everywhere in the world.

## Saprophytes

Oyster mushrooms are classified as Saprophytes. These are primary decomposers of organic matter in an ecosystem. They are capable of decomposing organic structures like **Lignin** and **Cellulose**, and leave behind minerals and nutrients to thrive on for other organisms to come. As they are very adaptive, Oyster mushrooms can be cultivated on a wide range of Cellulose based (waste) materials.

Oyster mushrooms use digestive enzymatic fluids to break down complex organic structures and to absorb nutrients. They even can kill small insects and digest them. They produce a variety of enzymes, thus they can cope with different substrates and substances, they can even be trained to break down certain materials, even plastics, oil or toxic wastes.

## Characteristics

In nature Oyster mushrooms grow on dead trees between late fall and spring. The mushroom has a Oyster-shaped cap, spanning 2–20 cm. Its color ranges from white to dark-brown. The cap margin is in-rolled during growth and starts to become wavy and roll out before spore production.

## Mushroom identification

Oyster mushrooms belong to the family of *Pleurotus*. This family consists of around 30 (known) species. It is hard to identify a mushroom just by its looks. Also it is very likely that mutations and hybrids appear.

A mushroom can only be identified by a combination of factors, which are its **look**, its **growing environment**, its **spore print**, and through **microscopy**.



day  
5

## What is a mushroom

The structure we commonly refer to as mushroom is only a small part of the actual organism. It is the reproductive, spore producing fruiting body of a **fungus**. You could say that mushrooms are the sexual organ of the fungi. The whole organism actually covers a huge area, growing below the surface. In the following I will refer to the fruiting body as **mushroom**, and to the whole organism as **fungus**.

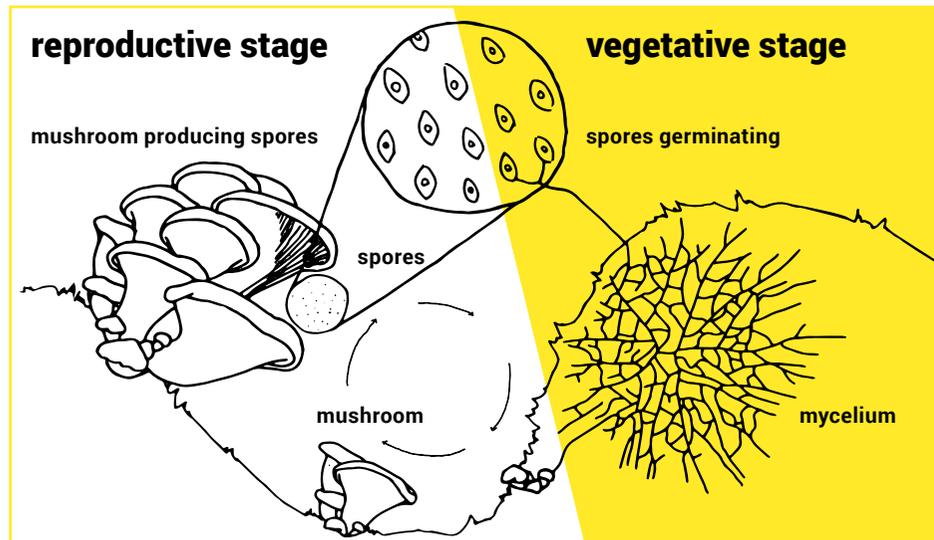
## Life cycle

To reproduce, fungi produce millions of spores, spreading them over the air. As soon as one of these spores settles in a beneficial environment, it can grow into mycelium – thus entering its first stage of growth, the vegetative stage, also known as spawn run or

**colonization**. During spawn run the fungus grows and takes in nutrients, preparing for its next stage, the **reproductive stage**. This is commonly referred to as **fruiting**. The fungus starts building fruiting bodies – mushrooms – which then produce spores and release them, in order to produce the next generation.

## Check your sample

**You should be able to see the mycelium grow out of the spawn by now. If this process has not started until today, this indicates that something went wrong. Check if you set up the environment correctly like described on day 3, check day 4 for troubleshooting. If you can see no changes until day 7, skip to appendix.**



day  
6



## Cultivation cycle

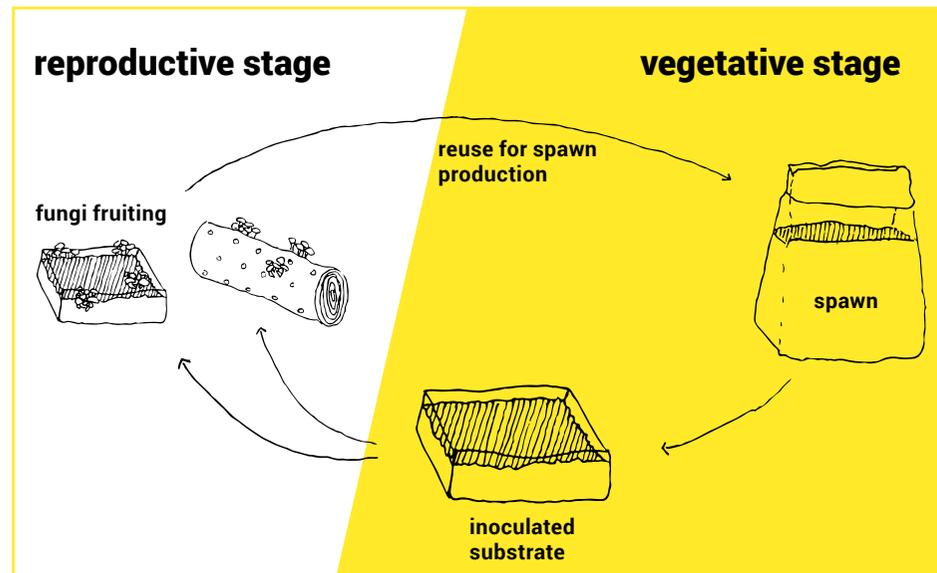
While cultivation, the whole life cycle is sped up by the grower. This is being done by mimicking natural weather conditions with an artificial growing environment, offering the ideal growth conditions. Oyster mushrooms can be cultivated within only 3 weeks.

The cultivation cycle consists of the same growth stages as in nature – vegetative and reproductive stage – but it doesn't start off with a spore. In cultivation, **spawn** is being used, which acts like a seed for the fungus to grow. By using a big number of these seeds the fungus' growth can be sped up.

## Different environments for vegetative and reproductive growth

Fungi require different artificial environments, mimicking different weather conditions. During spawn run, you need to fake the underground environment of fungi in spring, a dark and warm environment.

During fruiting you need to fake poor autumn weather conditions, high humidity or „rain“, cold temperatures and at some point sunlight and good ventilation.



day  
7



## Working with spawn

Spawn is the term for any organic material which carries a living fungus. That means, you can use any piece of fungi which is in its vegetative stage (mycelium is spreading, AKA spawn run) to start off mushroom cultivation.

Reproducing mushrooms from spawn basically means cloning them, or rather making the original organism grow again on a different substrate.

## Make your own spawn from cardboard

You don't necessarily need to buy spawn from the supplier, there are methods to produce your own spawn at home.

The most common way is to grow spawn from actual Oyster mushrooms, which you can get at the supermarket, the local farmer's market or you hunt them in the forest.

**The only important thing here is to use fresh mushrooms. You need to wet a piece of thick, multi-layered cardboard in water and let it drain, then peel off the top layer. Cut off the mushroom stems and place them on the cardboard, cover them with the peeled off piece and wrap them. Then put the whole thing in a closed container and let it grow for about 7-10 days in the dark. The mushroom stems will go back to the vegetative stage and mycelium**

**starts spreading all over the cardboard. As soon as the cardboard is completely cultivated by the fungus you can seed any substrate with it. Therefore rip it in pieces and mix it with substrate (see day 1 and 2 for the substrate recipe).**

**You can keep your spawn in a fridge for up to 2 months.**

## Different kinds of spawn

Spawn is relatively easy to make. You can even use old substrate from your previous cultivation to spread the fungus. Generally speaking, it is possible to grow fungi on any organic material and use it as spawn.

The shape of spawn defines the way you can use it. Big sheets of cardboard are good to cover big surfaces. If you want to cultivate a wood log you might want to use wood dowels as spawn.

Fungi prefer to colonize substrates which are similar to their original habitat, so try to match your spawn with the material you want to use as a substrate.

[goo.gl/Y70Uc6](https://goo.gl/Y70Uc6)

[goo.gl/jofXJm](https://goo.gl/jofXJm)



day  
8



## Substrate

The nutritious habitat on which fungi grow is called substrate, it is providing the organism with nutrients. By releasing digestive enzymes into the substrate, fungi break down its organic compounds and absorb the nutrients. These compounds mainly consist of Cellulose and Lignin, which are both important compounds of all organic materials, being the main constituent of plant cell walls. Both can not be digested by humans, fungi are one of the few organisms which can actually break down Lignin.

## Substrate ingredients

Substrates need different sized particles and structures. Good substrate compounds are straw, sawdust and wood chips. To increase the yield and the growth, speed nitrogen- and starch-rich supplements are added, good supplements are wheat bran and coffee grounds.

Fungi prefer to grow on a substrate with slightly low pH level. To reduce the pH it is sufficient to add a tiny amount of gypsum (about 1–5%).

## Custom substrates

You can add basically any organic material or waste to your substrate. You can experiment with supplements such as potato skins or even urine. Be aware that a higher levels of nutrients leads to higher risks of contamination.

There is much room for experimentation with other organic materials. You can grow mushrooms for example on shoes, books, toilet paper, or furniture. You find the basic substrate recipe which works for most fungi on **day 1 and 2**.

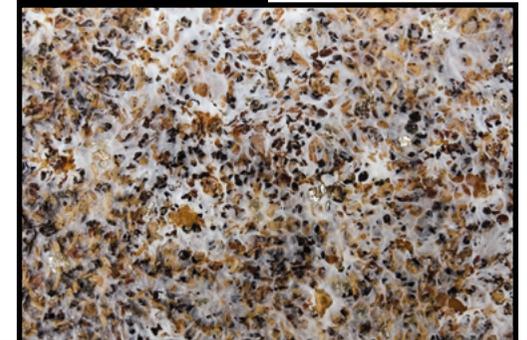
## Impact on the yield

Mushrooms are made of what they digest. They can break down complex structures like pesticides, yet they integrate all kind of molecules into their organism. That means, heavy metals and radioactive atoms can be found frequently in the (wild) organisms.

As fungi produce fruiting bodies to push out spores, they also push out all the poisonous substances. That means, it is crucial to use biological and clean substrates for growing mushrooms and take care for environmental pollution. If not, it can be very unhealthy to consume the fruiting bodies.



**day  
9**



## Heat treatment

When working with very nutritious substrates or big substrate containers, it might be sufficient to make it undergo heat treatment before inoculation. Heat treatment kills or neutralizes competing microorganisms.

If done properly, this decreases the risk of contamination during spawn run.

If you want to apply heat treatment to your substrate, you need to do this before inoculation, so before **day 2**.

## Steam sterilization

Steam sterilization is a very save method as it provides a heat treatment at 120°C which can sterilize the substrate and kill all possible contaminants.

This technique is usually done when working with nutritious substrates (e.g. coffee grounds).

A pressure cooker that is capable of reaching 1 atmosphere overpressure is required.

**Prepare jars (or any other container which can be closed and withstand the high temperatures). Work with containers or bags with a micro-filter. Fill them with substrate (see day 1 and 2), close the lids and pressure cook them for 30-60 minutes. You should place the containers on something which is higher than the water level, they should not touch the water directly.**

**Let them cool over night without opening the pressure cooker. Take care when you are adding the spawn (like on day 2), so that no contamination enters the container while it is open – work fast.**

## Pasteurization

Pasteurization is a very popular method as no pressure cooker is needed. The substrate is directly submerged in hot water, thus rough substrate materials like straw are usually used for this method. At a temperature of exactly 70°C this treatment doesn't kill all pathogens, but only those which could interfere. It keeps favorable microorganisms alive and only kills unwanted organisms.

**Heat water in a pot to 70°C, add the substrate and maintain the temperature at exactly 70°C for 60 minutes. Afterwards let the substrate drain and cool, then proceed with inoculation (like on day 2).**

[goo.gl/MsXEq3](https://goo.gl/MsXEq3)

[goo.gl/prG6tY](https://goo.gl/prG6tY)



**day  
10**



## Fungi as part of the carbon cycle

Fungi do have a big impact on their local ecosystems. Like all living organisms they are part of the carbon cycle.

Living things are made of carbon-based molecules. This carbon is constantly exchanged and recycled, a process, which makes Earth capable of sustaining life. The mycelium of fungi is the major biomass in Earth's soil, this gives fungi a key role in the global carbon cycle.

Their mycelial filaments are in direct contact with uncountable organisms. They decompose and recycle organic debris, particularly dead wood.

On the other hand they are living in a symbiotic relationship with plants, sustaining them with nutrients.

While mycelium nourishes plants, mushrooms are nourishment for bacteria, insects, mammals and other organisms.

## Diversity

There are about 1,5 million species of fungi of which 10 percent are what we call mushrooms, and only 10 percent of these mushroom species have been identified so far. They are a key factor for making an environment habitable. A healthy environment directly correlates with

fungi diversity. All habitats depend on fungi, without them the carbon cycle would collapse.

Mycelium vitalizes the soil, its enzymes strongly affect the soil's structure and condition.

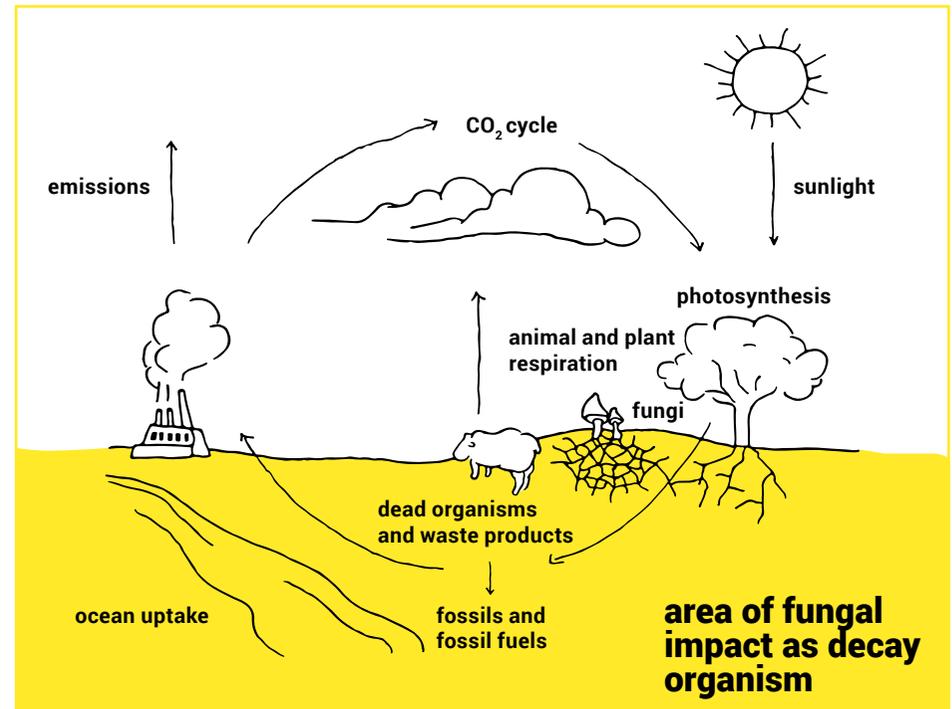
## Human impact

Since human intervention, biodiversity decreases, mono cultures lead to the destruction of complex symbiotic relationships. Most fungal species are not very adaptable to such serious changes and disappear.

Especially deforestation and mono cultured forests have a big impact on the diversity of fungi. Most fungi grow in very specific ecosystems and depend on various factors, animals and plants. Only a few species can cope with changing conditions (Oyster mushrooms are one of them, this is the reason why they are so easy to cultivate).



day  
11



## **Mycorrhizae**

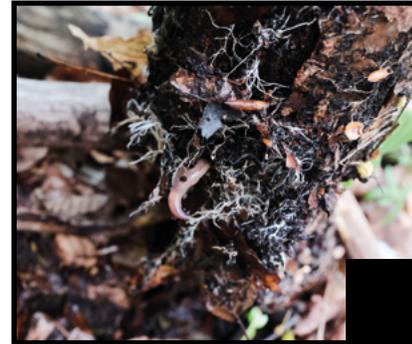
90% of all land plants are in mutually-beneficial relationships with fungi. The fungi of these relationships are called **Mycorrhizae**. In mycorrhizal associations, fungi colonize the roots of plants (without harming them) to exchange nutrients. The plants provide fungi with carbohydrates, in exchange fungi help plants to suck up water and provide nutrients like phosphorus and nitrogen.

Fungal mycelium is a dense net of filaments which can cover thousands of acres and connect millions of organisms. Plants use the mycelial network to send chemicals and substances to communicate or support each other. Also they might send toxic substances to fight unwanted intruders. Some plants use the network to communicate and warn each other from harmful insects or diseases, preparing to fight those pathogens.

The mycelium of mycorrhizal fungi is the major microbial biomass in soil. If mycorrhizal fungi disappear, forest trees which are in symbiotic relationships with mycorrhizal fungi will gradually disappear.

[goo.gl/oX91xR](https://goo.gl/oX91xR)

[goo.gl/sFm0W7](https://goo.gl/sFm0W7)



**day  
12**



## Mycelial Internet

Mycorrhizal fungi connect many plants with their mycelial network. One square centimeter of soil contains around 1km of mycelial filaments, if placed end to end. Mycelium constantly expands and is capable of covering thousands of acres in size, becoming one huge organism. This mycelial network is directly in contact with millions of organisms, exchanging chemicals, nutrients and enzymes. It is an information network, creating interactions between a large, diverse population of individuals. Scientists call mycelium “the neurological network of nature”, linking roots of different plants – it is nature’s Internet.

## Wood wide web

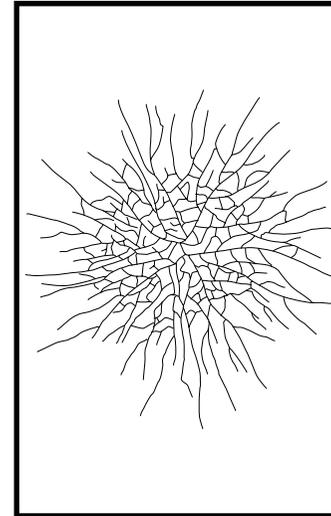
Plants are not just growing by themselves, but contributing to the whole, sharing nutrients and information through the mycelial web. Many biologists have started to use the term **wood wide web** to describe the communication service that fungi provide, linking between plants and other organisms. The wood wide web makes communication between plants – including those of different species – possible. Most of the plants we see are connected below ground via mycelial connections.

## Impact on ecosystems

This indicates that plants are not just individuals, trying to survive for themselves, they are helping out each other. This exemplifies one great lessons of ecology: seemingly separate organisms are often connected and may depend on each other. Taking out one part of the ecosystem might affect the whole rest in a defeating way.

[goo.gl/OsoZqh](https://goo.gl/OsoZqh)

[goo.gl/gMjLwN](https://goo.gl/gMjLwN)



day  
13



## Mycorestoration

Mycorestoration is the use of fungi to repair or restore an environment, damaged by humans, natural disaster or disease. Common practices are *Mycoremediation*, including *Mycofiltration* (cleaning water), *Mycoforestry* and *Mycopesticides* (pest and insect control).

## Mycoremediation

Environmental remediation is the removal of pollution from an environment. As fungi can take in toxic substances and pollutants very well, they are being used for remediation. Fungi are capable of breaking down various (toxic) substances like pesticides, plastics and even oil. The fungus takes in these substances and transports them out to the surface together with its fruiting bodies. Yet, to prevent them from going back into the ecosystem, the fruiting bodies need to be treated like toxic waste.

## Health issues

Mushrooms can collect different kinds of heavy metals, Oyster mushrooms mainly store cadmium, lead, arsenic, iron, copper, radioactive caesium. Even though fungi can contain heavy metals, they can never be toxic enough to poison you, still these toxic substances will be stuck in your body and potentially weaken your immune system. Fungi cultivated for food consump-

tion are being grown on non-toxic substrates, being unaffected by radiation and heavy metals. But mushrooms from the forests in some areas of Europe can still contain a heavy amount of caesium, due to the Chernobyl disaster.

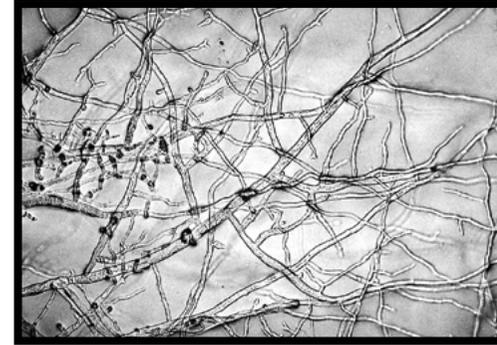
## How the substrate affects the mushroom

Fungi are what they eat, they will take every substance from the substrate and use it as nutrition. You need to know what is in there and only use safe materials for your substrate.

[goo.gl/8LSTzw](https://goo.gl/8LSTzw)

[goo.gl/48CnWb](https://goo.gl/48CnWb)

[goo.gl/jMc4Lq](https://goo.gl/jMc4Lq)



day  
14



## Medicinal properties

Mushrooms produce medicinal and beneficial substances. Oyster mushrooms can be used for treating excessive blood cholesterol, they work anti-cancerous and antiviral, antibacterial, cardiovascular and as a nerve tonic.

These substances are usually higher concentrated in the cap and especially in the spores.

As the stems can be very tough, preferably just eat the caps and use the stems for spawn production. Be sure to harvest the fruiting bodies before sporulation in order to consume the spores as well, which contain a lot of valuable bioactive substances.

## Oyster mushroom's nutritional properties

Oyster mushrooms contain many beneficial compounds. They are low in fat, simple carbohydrates, cholesterol, vitamin A and vitamin C. They are rich in protein (3-30%), polysaccharides, antioxidants, B vitamins (B2, B3, B5) and vitamin D2, dietary fiber, essential minerals (selenium, copper, potassium) and medicinal compounds like natural antibiotics and enzymes.

## Data sheet

100g of Oyster mushrooms contain:

Calories 43.0 (180 kJ)

Water 88.8g

Protein 3.3g

Carbohydrates 6.5g

Fat 0.4g

Fiber 1.0g

Vitamin B1

Vitamin B2

Vitamin B3

Vitamin B5

Vitamin D

Calcium

Copper

Iron

Potassium

Oyster mushrooms contain a variety of other minerals, vitamins and bioactive substances more.

## Check your sample

**Your sample should look something like this by now, with a healthy, fluffy white coating. If this is not the case, give it more time, until it is fully cultivated before you proceed.**

[goo.gl/QSSy7c](https://goo.gl/QSSy7c)

[goo.gl/KqMNpA](https://goo.gl/KqMNpA)



day  
15



**Proceed only, if the mycelium has covered the whole substrate and you see yellow fluid appearing on it.**

**If not, give it a few days more time.**

### Initiate fruiting

Spawn run is over, when the mycelium has covered the whole substrate and secured all nutrients accessible. At this point it needs certain environmental conditions to enter the reproductive stage. Therefore you need to mimic weather conditions and create "autumn weather", to make the mushroom switch from vegetative stage to reproductive stage, which will initiate fruiting.

### Environment for fruiting

**Remove the lid and provide the fungi with fresh air and light. For 24 hours, lower the temperature to 5-10°C less than during spawn run (put it outside for example). A humid environment is very important, keep your fungi moist by spraying water several times a day. Provide an environment with 85-95% humidity, you might want to build a fruiting chamber in a transparent plastic box with holes for air supply.**

**Within 3-4 days, tiny baby mushrooms**

**rooms are going to be formed, which will develop into full grown fruiting bodies. This is called the first flush.**

An other way to initiate fruiting is to put it outside in the garden, cover it with earth and leave it up to nature to produce a yield. This of course will take much longer.

### Environmental conditions during fruiting

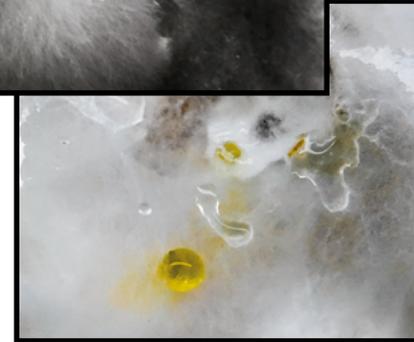
Fruiting is most affected by its environmental conditions during fruiting. Most crucial factors are Oxygen supply, humidity and light. If your mushrooms won't develop like expected during the next days, this often can be traced back to a faulty flushing environment, check **day 17** for troubleshooting.

[goo.gl/e6G42C](https://goo.gl/e6G42C)

[goo.gl/Uz9o5i](https://goo.gl/Uz9o5i)

[goo.gl/QMUL7w](https://goo.gl/QMUL7w)

[goo.gl/IEICLW](https://goo.gl/IEICLW)



**day  
16**

## Flushes

A fungus produces fruiting bodies as long as it has the capacity, the nutrients and the right environmental conditions. The mushrooms get produced in waves, which are called flushes. After each harvest the fungus needs a resting time to gather nutrients and prepare for fruiting again, usually this takes 5-10 days. In that time the fungus switches back to the vegetative stage (spawn run). This is the beginning of another cycle, eventually leading to the next flush.

### Prepare for the next flush

**After harvesting, soak the substrate in water for a few hours, let it drain and put it in the environment for spawn run – like described on day 3 – until it looks healthy and fluffy again.**

You can repeat this process up to 5 times, in the best case. Continue with cultivation as long as the mycelium stays white and firm, and as long as no mold appears.

### Troubleshooting while fruiting

If your mycelium does not produce any baby mushrooms, but you think that you are doing everything correctly (*humidity, Oxygen, light*), spawn might not be finished yet.

**Give it a little more time, send it back to its dark and moist environment and try it again in a few days.**

Don't be worried if you see the baby mushrooms dry out. Only a few will grow into full grown fruiting bodies, it is perfectly normal for the majority of them to stop growing at some point.

If your mushrooms grow into misshaped fruiting bodies with long stems and small caps, this means that your Oxygen supply is too low.

**Provide it with more fresh air.**

If your fruiting bodies seem to be dry and thin, this means that you don't provide the necessary humidity. **Spray the mycelium with water more frequently during the day to keep the humidity high. Consider using a fruiting chamber.**

Sometimes during the process, flies might appear. They are usually attracted by mycelium which has had some flushes already. These flies are rather harmless (just annoying) and there is not a lot that you can do. **I recommend to do the next flush outside.**



## Material alternatives

Fungi offer an alternative to synthetic, unsustainable materials. Mycelium based materials can be made from organic wastes. The fungus acts as a kind of glue and “grows” the substrate together. Depending on substrate, fungal species and after-treatment, various material properties can be achieved, flexible, foamy, cork-like, leathery, wood-like or even stronger.

## Properties

Mycelium based material is **self-extinguishing** and **fire proof**, therefore it is being used for insulations and architectural panels. It is **floating** on water and **water-repellent**, which makes it perfect for buoys or rafts. It is **lightweight, strong** and **pressure-absorbing**, thus it is being used for packaging and furniture. It can be grown in all kinds of shapes with all kinds of specifications and material properties.

## Applications

There is a growing interest in biologically produced materials. At the moment it is hard to come up with an economic production process, considering the time-consuming and sensitive organism. Yet, if the industry will adapt and develop more efficient methods and machines, mycelium based material might be as cheap and available in the future as plastics nowadays.

## Material alternatives

**MycoWorks** is producing mycelium based material alternatives. Their leather alternative is promoted as cost-competitive and as performative as animal leather. It is being produced by using waste materials.

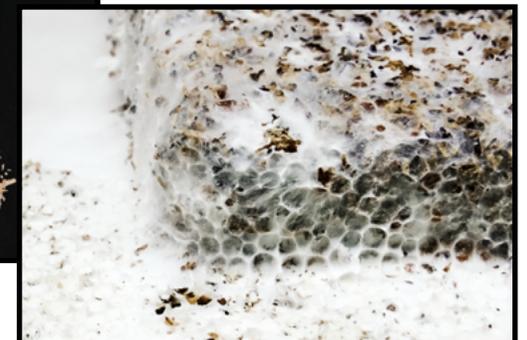
**Ecovative** is a company which creates various fungi-based materials. Their Myco-foam replaces expanded foams like Styrofoam and offers a sustainable, economically and environmentally friendly material alternative.

**MOGU** aims to replace petroleum-based plastics with mushroom-based materials by using naturally grown fungi materials. Their current products feature architectural panels, flooring, pots, and containers.

[goo.gl/38iKGs](https://goo.gl/38iKGs)

[goo.gl/jJ10UM](https://goo.gl/jJ10UM)

day  
18



## Mushroom farming business examples

Fungi-based materials can be used as practical applications. But also mushroom farming can be a profitable business.

## United Nations mushroom cultivation guide

In fact they can be grown very sustainable, thus small scale mushroom cultivation practices are being promoted by the United Nations for developing countries. Those practices can become a sustainable and cheap small business, contributing to one of the big health issues on the planet. 30% of the world population has a protein deficit, fresh mushrooms contain around 5% of protein, which can be basically harvested from waste products.

[goo.gl/661rhA](https://goo.gl/661rhA)

## Business models

Austrian small business *Hut & Stiel* is literally making food from waste. They work together with various restaurants and cafés, collecting their daily waste production of coffee grounds. These are then being used as substrate for Oyster mushrooms, being grown in a small basement space. Hut & Stiel represents a way of urban farming, which uses existing resources in a sustainable way in cooperation with

local partners. They want to take part in a sustainable food production, a clean surrounding, showing the potential of waste products and encouraging a nutritionally conscious society.

[goo.gl/4eRGHO](https://goo.gl/4eRGHO)

[goo.gl/MdP1Nd](https://goo.gl/MdP1Nd)

Dutch company *Roterzwam* follows a similar approach of urban farming. Their focus lies as well on locally produced and consumed food, working with a circular design approach. They are especially raising consciousness about the sustainable alternative mushroom farming offers in comparison to meat cultivation, in terms of water usage and CO2 production.

[goo.gl/q6Cjlg](https://goo.gl/q6Cjlg)

[goo.gl/wdRtWL](https://goo.gl/wdRtWL)



day  
19



## Psilocybin

Psilocybin is a naturally occurring psychedelic compound produced by more than 200 species of mushrooms, commonly known as “magic mushrooms”. It has mind-altering effects similar to those of LSD or DMT. The effects include euphoria, hallucinations, changes in perception, spiritual experiences, and of course possibly nausea or panic attacks.

Human use of Psilocybin dates back for thousands of years. Nowadays, possession of psilocybin-containing mushrooms has been outlawed in most countries.

## Trips

The intensity and duration of the effects of psilocybin vary, depending on species, dosage, individual psychology and setting. The effects typically last from 2–6 hours, although this time might seem longer, since the drug can distort the perception of time.

## Terence McKenna

Terence McKenna was an American ethnobotanist and author, promoting the responsible use of naturally occurring psychedelic plants. Throughout his life he proposed several theories like the Stoned Ape theory, or the theory that mushrooms are extraterrestrial organisms. McKenna always stressed the responsible use of psychedelic

plants, saying, “Experimenters should be very careful. One must build up to the experience. These are bizarre dimensions of extraordinary power and beauty.” He died in 2000 due to brain cancer.

## Mushrooms from space

Terence McKenna proposed the idea, that fungi did not originate on Earth. Throughout his life, McKenna continued working on this theory and came up with the story of Psilocybin during the last one billion years. He believed that fungi could have been sent from a civilization far away, to seed genes on habitable planets (like the Earth).

[goo.gl/6Pmwgs](https://goo.gl/6Pmwgs)

[goo.gl/wD3TZt](https://goo.gl/wD3TZt)

[goo.gl/1R5Abk](https://goo.gl/1R5Abk)

[goo.gl/eh1ryJ](https://goo.gl/eh1ryJ)



day  
20



## Stoned ape theory

In 1992, Terence McKenna published the “Stoned Ape theory”. McKenna suggests that naturally occurring psychedelic substances played a decisive role in the emergence of human consciousness and evolution. McKenna points out the various effects Psilocybin has on primates (like sexual arousal or increased vision) as evolutionary advantages. He states that the human language-forming ability might have emerged through the influence of hallucinogens, working in brain areas that are concerned with the processing and generation of signals.

McKenna’s theory proposes, that due to climate changes the African jungle started to shrink, which made it necessary for our primate ancestors to open up new niches, consequently coming down from the trees and finding food sources on the ground. Among their new diet were psilocybin-containing mushrooms. Being introduced to this drug resulted in the emergence of us, McKenna states.

## Critique

McKenna’s theory emerged of intuitive ideas, own experiences and great rhetorics, but mostly it is based on many suppositions combined with the few known facts of early human history. Because McKenna is also prominent for even wilder theories, this – in comparison – far more reasonable theory is still disregarded by most scientists.

[goo.gl/iKGPZ4](https://goo.gl/iKGPZ4)

[goo.gl/BiPghe](https://goo.gl/BiPghe)

[goo.gl/mnAtjg](https://goo.gl/mnAtjg)



day  
21



**Proceed only, if you actually spot full grown mushrooms on your substrate by now.**

### **Harvest**

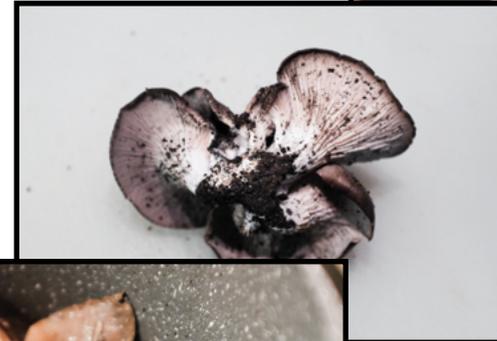
Fruiting bodies usually are ready to harvest within 4–5 days after the first pinheads have appeared. Oyster mushrooms grow in clusters, they are harvested by softly twisting off the whole cluster. They should be harvested before the cap flattens and the mushroom still has a convex shape.

### **Cooking**

While being fried, some of the medicinal properties of the mushroom are getting lost. To keep the medicinal substances, briefly blanch them or eat them in a soup. Of course you can prepare them however you like them best. My personal preference is frying them in olive oil or baking them in the oven.

### **Preservation**

Keep the fresh mushrooms in the fridge and eat them within 2–3 days. You can dry the mushrooms to preserve them. You can also powder them and use the powder for soups or as a food supplement. If you dry them, do it at low heat, below 40°C.



**day  
22**

## Spent substrate

Spent mushroom substrate is the leftover substrate after several flushes (4–5 flushes, or less), which is not capable of producing an other yield.

You can use it as a fertilizer for your plants. Crumble it and mix it with soil, or use it as a fertilizer on the surface.

If it is a straw-based substrate it can be used as food for farm animals like chicken and pigs. It is a great supplement for worm composts.

## Nutrition

Spent substrate is considered as very nutritious, as it contains sufficient amounts of nitrogen, phosphor and potassium (depending on fungal species and substrate compounds).

[goo.gl/7JFZYN](https://goo.gl/7JFZYN)

day  
23



## What to do, if things go wrong

I hope you never need to skip to this page. If you do, this means, that something went wrong on the way and there is no easy way to fix it, your cultivation efforts failed, this time. This is no reason to be sad. You are working with living organisms, simulating highly complex natural processes. In this context things can easily go wrong. You are not the only one here, this is usual to happen from time to time.

## Understand what went wrong

It might not have been your mistake. Check the troubleshooting pages on **day 4** and **day 17** to see, if you can figure out the faults. To identify what failed your cultivation is often hard to do.

## Keep it up

Don't lose your motivation at this point. This is how these things work. Faking natural processes does not have a 100% success rate, as not even nature itself has one.

## Start again

Great decision. Check this page for material- and spawn-suppliers. You can find a list of necessities in the **preface**.

Don't hesitate to continue these day-by-day instructions to gradually accumulate your knowledge and be best prepared for the next try. Feel free to contact me anytime, send a mail to

[fungi@danielparnitzke.de](mailto:fungi@danielparnitzke.de)

## Further reading

[shroomery.org](http://shroomery.org)

[mediamatic.net/page/39299](http://mediamatic.net/page/39299)

[radicalmycology.com](http://radicalmycology.com)

[alohamedicinals.com](http://alohamedicinals.com)

**Book: Paul Stamets – "Mycelium Running" and "Growing Gourmet and Medicinal Mushrooms"**

**TED talk: Paul Stamets**

**Youtube: Terence McKenna**

## Spawn supplier

[gluckspilze.com](http://gluckspilze.com)

[gombacsira.hu](http://gombacsira.hu)

[pilzzuchtshop.eu](http://pilzzuchtshop.eu)

[sylvaninc.com](http://sylvaninc.com)

## Material supplier

[gluckspilze.com](http://gluckspilze.com)

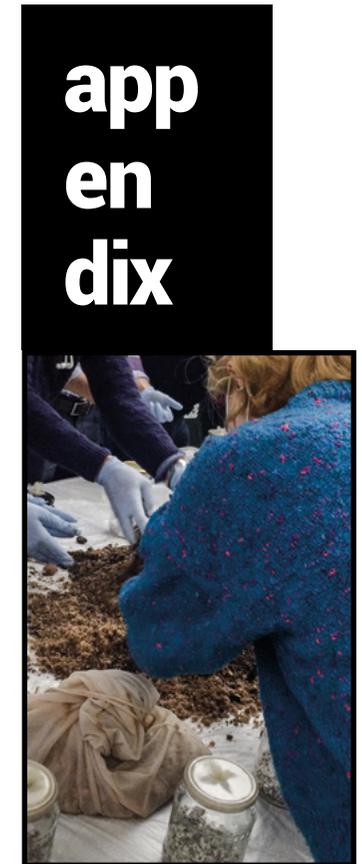
[pilzzuchtshop.eu](http://pilzzuchtshop.eu)

**Fressnapf, dm, Obi (and other)**

**Local farmers or wood workshops**

**Local cafés and restaurants**

**Pharmacies**



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dix

## Daniel Parnitzke

I'm a designer from Germany. I first started growing mushrooms as an intern at Amsterdam based Stichting Mediamatic. Since then I'm incorporating fungi as well as other living organisms in my design projects, exploring their useful properties and potential applications and rising awareness for sustainable (living) material alternatives.

[www.danielparnitzke.de](http://www.danielparnitzke.de)

This content was created during a three month residency at Kitchen Budapest

[www.kibu.hu](http://www.kibu.hu)



## Share your process

[Upload your process on](#)

[fungi.danielparnitzke.de](http://fungi.danielparnitzke.de)

## Get in touch

Feel free to contact me if you have an idea for a collaboration. I want to encourage hobbyists mycologists and professionals to contribute, criticize and give feedback to this introduction to fungi. Send an email to

[fungi@danielparnitzke.de](mailto:fungi@danielparnitzke.de)

## Disclaimer

This content is an ever changing work in progress. Some processes are extremely simplified, some important facts are skipped due to the sake of understanding and fun. The content is based on my experience, knowledge, and opinions. Thanks to **Natalia Borissova** for providing me with a lot of information with her workshop.

[aa-vv.org/node/209](http://aa-vv.org/node/209)

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– Barnabás Neogrady-Kiss

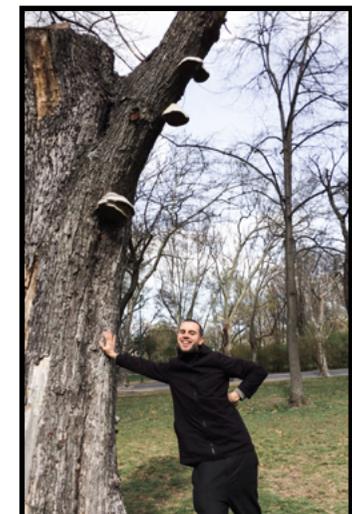
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Daniel Parnitzke  
[fungi@danielparnitzke.de](mailto:fungi@danielparnitzke.de)  
[www.danielparnitzke.de](http://www.danielparnitzke.de)