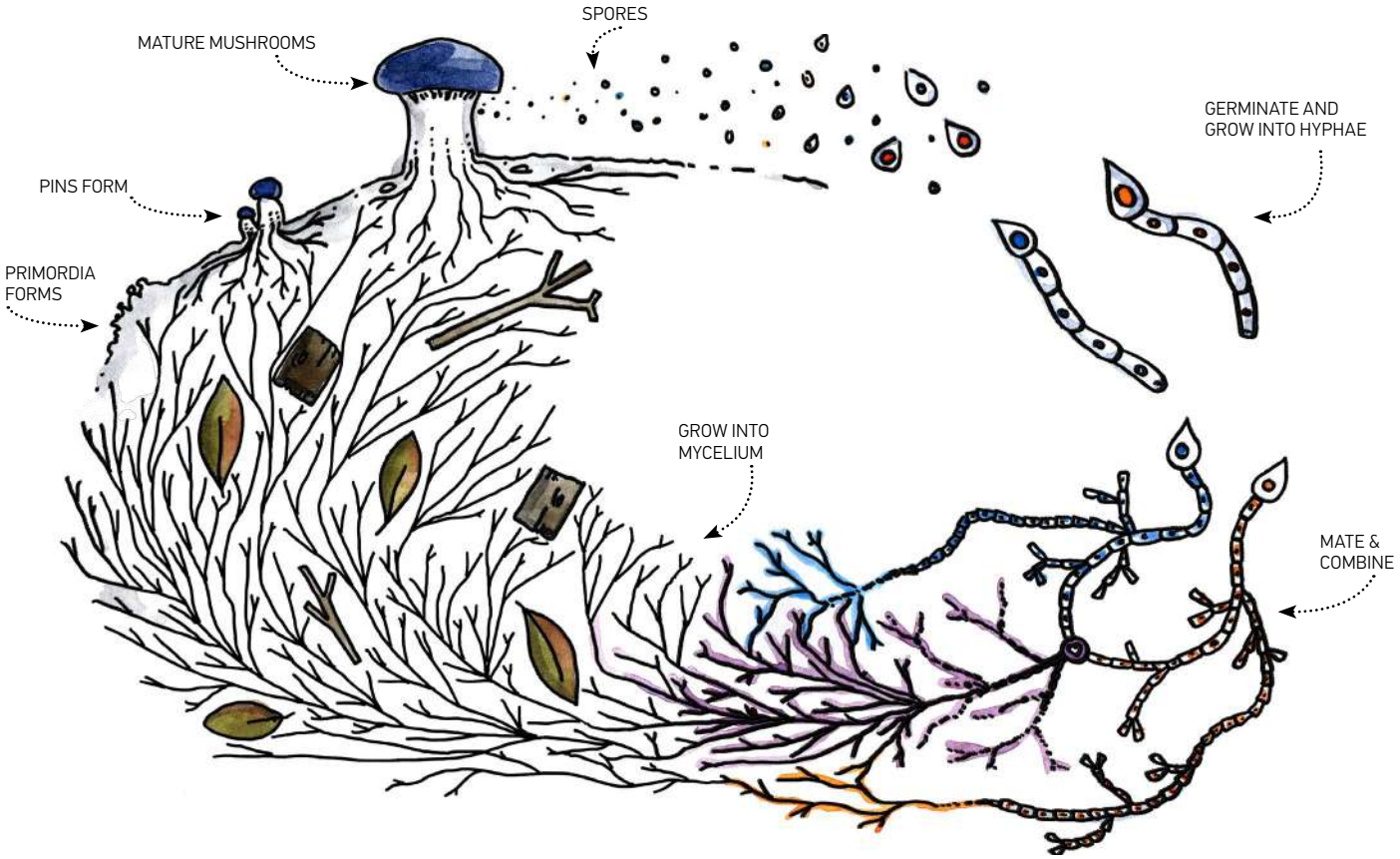
Milkwood

THE SEX LIFE OF FUNGI

IN-DEPTH LIFECYCLE OF MACRO-FUNGI



Mushrooms start off as **spores**, released from a mushroom much like seeds from a seed pod.

When a spore lands on a suitable substance, it grows into a **hypha** – a little thread composed mainly of mycochitin, a similar substance to that which crustaceans (like prawns or shrimp) use to make their shells.

When two or more **hyphae** grow near each other, they bond together and share their genes to produce **mycelium**, a large network of hyphae, looking a little like a branching web of delicate white threads or roots.

Different mycelium eat different things. Some break down whatever woody substances they can get close to. Some mycelium have special relationships with certain tree species, sharing sugars and other nutrients with plant roots. Some mycelium eat insects, or live within them.

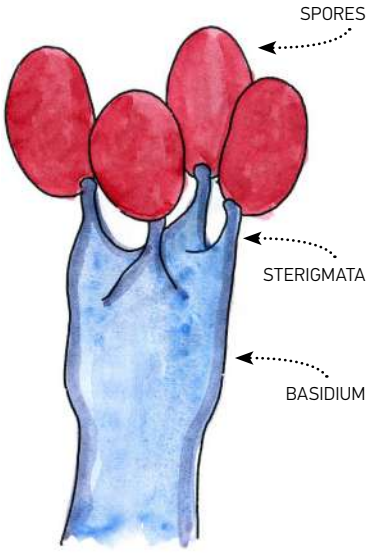
Once the mycelium has run through and eaten as much of its chosen food as it can, and when conditions are right, the mycelium will start to form fruiting bodies in the form

of **mushrooms**, to reproduce and extend its territory.

Mushrooms are incredible little pieces of life. They're 'anti-gravity', meaning they'll push upwards with uncanny force, through wood or soil or sometimes even asphalt in a bid to get up into the fresh air and the light, to spread their spores.

Just a few days later, they're rotted and gone. Like peaches, mushrooms are a tasty, unprotected food – their mission is to be eaten. In the process of being knocked about, picked up or generally taken apart, their tiny spores spread near and far, in their millions, with some spores landing in just the right spot to begin the process of life all over again.

Let's take a deeper look!



ABOVE: Basidia structure.
RIGHT: The gills of a Saffron Milkcap, where the microscopic basidia reside.

THE SEX LIFE OF FUNGI – HOW MUSHROOMS SPREAD THEIR SPORES

BASIDIOMYCOTA & ASCOMYCOTA

Species that produce mushrooms fall into two broad divisions Basidiomycota and Ascomycota. They are often abbreviated to "Basidios" and "Ascos" in mycological slang.

Ascos include species like the morel mushrooms, cordyceps & truffles but apart from these, pretty much all the mushroom species that you know and love are Basidios. This includes oyster mushrooms, shiitake, wood ear, chanterelle, reishi, porcini and the common button mushroom.

So we're going to take a closer look at how species in Basidiomycota produce their spores.

Nestled deep within the gills, tubes or pores, the Basidio mushrooms have these tiny little club-shaped, spore producing structures called "basidia".

At the end of the club are several narrow, rigid prongs where the spores are formed. Those prongs, the sterigmata, also act as launch pads for the spores[1].

When conditions are just right - perfect humidity, and the spore is at the perfect stage of development - a tiny water droplet forms at its base. When the droplet grows large enough its surface tension is broken and the spore is launched with incredible force to get away from the mushroom.

Imagine that microscopic spore being "pooted" out of the mushroom and up into the air (For the record, "pooted" isn't the technical term, it's "sporulate"). The spore might just float right back to the mushroom it came from and get stuck. So instead, it fires it out with an incredible amount of force. In fact, a mushroom spore can be launched with twenty-five-thousand times the force of gravity out into the air currents to begin its journey to find new organic matter to consume.

Sporulation is the strongest, single force measured in the natural world by a very long way. But as the spores are so very small, they almost instantly hit the air and slow down, but it's enough to set them free.

1. https://www.anbg.gov.au/fungi/spore-discharge-mushrooms.html

Mushrooms sporulating - still from video by Almir Rizvanovic https://www.youtube.com/channel/UCyrz5klBhZhVh362J8UXgvg/videos
BELOW: Overbeck jet shape.

SHAPE AND PULSES

Now, a fungus needs that spore to be carried away by the wind and even that massive effort to eject the spores may not be enough to catch a breeze. So fungi have developed a few more tricks to help carry their spores further afield.

The gills under many mushrooms are like the fins of a radiator. They've evolved for maximum surface area, which helps them fulfill one of their main jobs: to cool the air around them by releasing moisture. As the water changes from liquid to gas, it absorbs a lot of heat. Mushrooms seem to pulse this evaporation to generate subtle currents that can lift their spore metres into the air.

You might have also noticed many mushrooms also have a stereotypical mushroom shape. Bill Mollison the co-originator of the permaculture concept referred to this shape as an Overbeck jet. It's a very specific pattern that occurs in flows of air or water and it seems to help in the dispersal of spores.

At night time, if you go out to a shiitake log covered in shiitake mushrooms, armed with a bright torch, you can watch the mushrooms pulse like a coral reef all in sequence. They all pulse at the same time to all lift their spores up meters above the surface of the mushrooms in order for them to catch a breeze and to travel as far as possible.

Check out Almir Rizvanovic's beautiful footage, linked in the image credit on this page.

For all that immense effort of spore production, ejecting the spores, pulsing furiously to lift them into the air to spread, they often don't get very far. In fact, studies of spore distribution show that the vast majority travel less than about 9 metres (30 feet) before falling to the ground.

So to overcome these odds a single mushroom may launch over 30,000 spores per second

With that number being released some of them are sure to get away - and get away they do - they've been found in space, and in just about every environment on earth.

OVERBECK JET SHAPE

Seeking out the best place to germinate and grow new hyphae in the search for another compatible fungi of the same species to continue the cycle of life.

Macro-fungi use all sorts of different strategies to spread their spores. Wind blowing, insects foraging, mammals looking for a tasty snack and the impact of raindrops just to name a few, so it makes sense that their fruiting bodies will be very different depending on their climate, ecology and on which variation on a strategy they have evolved to use to spread their spores.

SPORES

First, let's look at something a little more familiar: a typical, seed-producing plant. If that seed falls and it lands in the right conditions, it will germinate and grow another plant. The seed has the entire genetic code inside it - all the instructions in the form of a full set of chromosomes in it, that are required to grow another generation of that plant and for it to flower again. The breeding bit happened back when a bee came along and pollinated the flower, which resulted in that first seed.

Spores operate quite differently. In fact, they're another example of why fungi are more like animals than plants.

So, a mushroom somewhere has just pooted out a few billion spores and we've got spores floating through the air.

Each microscopic spore has (among other things) a mating type. In a sense spores can be different sexes. - unlike seeds, they are more like animal sperm or eggs and just like eggs and sperm, each spore only has half the chromosomes required for the organism to complete its life cycle. They have what is called a haploid (or half) set of chromosomes.

LEFT: King Oyster Mushroom at various stages, including primordia, pinning and small mushrooms.

GERMINATION

Now if a spore lands on a suitable material, in a suitable environment, it will proceed to germinate. Yes, even though it's only got half the chromosomes required. Stay with us here...it starts to grow... now that's really different to how it works with animals. The spore can actually grow even though it only has a haploid set of chromosomes. Sperm and eggs can't do that.

If our little spore landed on, say, a sheet of stainless steel, it would probably just sit there. It needs the right amount of water, the right food & the right temperature to take the next step and to start to grow.

If it DID land in the right conditions, then off it goes - growing and branching and exploring the world around it looking for food. But before it can proceed to maturity and produce spores of its own, most macro-fungi need to get a full set of chromosomes - and to do that they need to find a partner.

In the diagram of the fungi life cycle, we've got some spores which are shown with a blue centre and some which are shown with an orange centre, that's to suggest two different mating types. At this scale the concept of male and female doesn't really make much sense so we'll just use colors to define the sexes. So we've got the orange sexed one growing, producing a

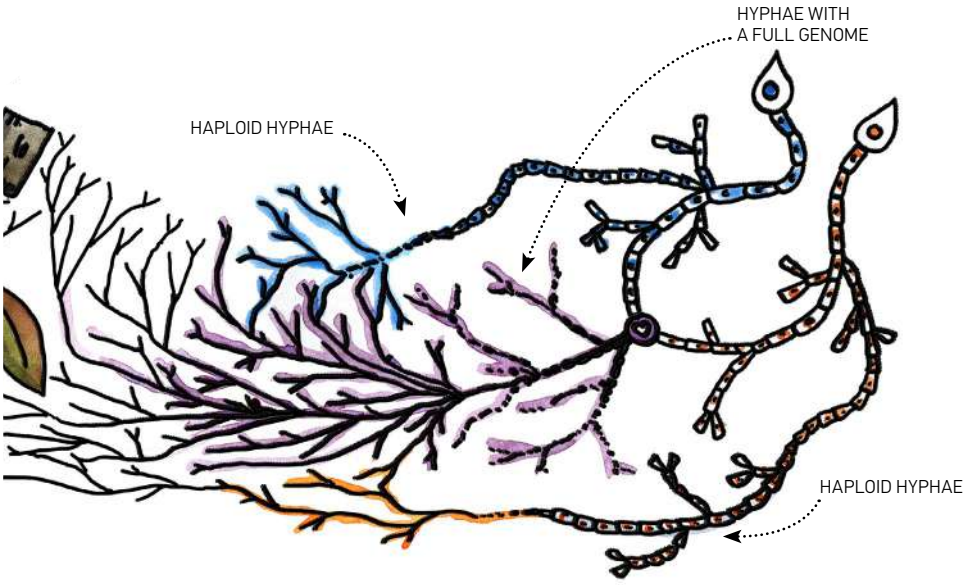
hypha (a little, single-cell-wide thread) it can continue to grow and branch, producing more and more hyphae. The blue sexed one starts growing there too, also producing its own hyphae.

If they find each other and they are compatible then things can get interesting. The two different mating types come together and share their genetic material. Love happens and then off it grows[2]. Notice that some of the hyphae produced after joining get chromosomes from both of the parent spores. They are indicated by the purple colour, they have a full set of chromosomes. But the haploid hyphae, the ones with the half set, can continue to grow too and all three types produce more and more little filaments.

So, the spores germinate, they find a partner, they share their genes, and then they continue to grow together with a full fungal genome.

But we're talking fungi, so of course, it's not that simple! In our diagram we've got the orange sex and the blue sex, and some mushrooms do have two sexes. But depending on what species of fungi, some have eight sexes or even more. There's even the fantastically named fungi Schizophyllum commune, the split gill fungi, that has over 20,000 different mating types or sexes. It's been a particularly successful fungi which has spread to almost every continent.

When a fungus has more than 2 sexes, there's usually some biological "rules of engagement" around which of the many alternative sexes are compatible with others, apparently it all ensures that a fungus is less likely to inbreed. If you're interested in trying to wrap your head around this, start with the excellent article by Professor Tom Volk footnoted below.[3]



TOP: mating spores showing full genome and haploid hyphae. BOTTOM: Schizophyllum commune fungus.

So the sex life of fungi is really really out there. And it gets wilder still.

If our little spore lands in the perfect spot, grows hyphae and doesn't find a suitable partner to swipe right on, does it wither and die from a broken heart?

Sometimes.

But sometimes, it continues to grow, producing enormous masses of haploid hyphae. While it will never be able to fruit, it's still growing as a legitimate organism, with only half its genome. That's pretty wild.

So there you go. A few of the intimate secrets of marvelous fungi and how they really work.

2. It's a little more complex, read this for a better understanding https://www.mykoweb.com/articles/GeneticIndividualsMosaics.html
3. Professor Tom Volks Article: https://botit.botany.wisc.edu/toms_fungi/feb2000.html