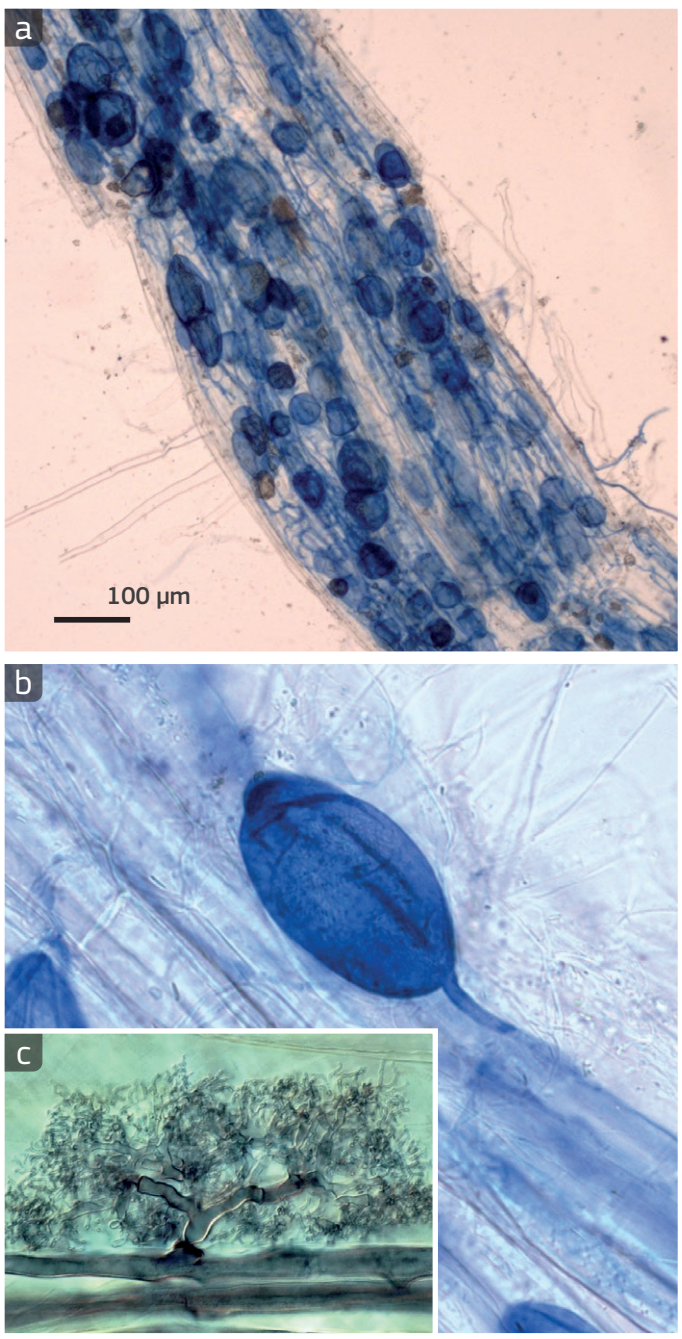
Fungi – Mycorrhizal fungi

Morphology

Mycorrhizas are literally 'fungus-roots' created by symbiotic associations (see box, page 33) between plant roots and fungi. Mycorrhizal fungi help their host plants acquire mineral nutrients from the soil in return for plant sugars. Mycorrhizal fungi form structures outside and inside plant roots. All types form extensive networks of microscopic hyphae that extend outwards from plant roots into the surrounding soil or leaf litter. Arbuscular mycorrhizas (AM), ericaceous mycorrhizas and orchid mycorrhizas are sometimes called 'endomycorrhizas' because the fungi form distinctive structures between and inside the cortical cells of plant roots, but do not generally cause obvious changes in root morphology. By contrast, ectomycorrhizas (EcM) often cause distinct changes to roots that can be observed without a microscope. Reproductive structures also differ among mycorrhizal types. Arbuscular mycorrhizal fungi reproduce with microscopic spores produced in the soil or within plant roots, whereas many ectomycorrhizal fungi reproduce with mushrooms or underground truffles. [38]



Stained roots (**a**) show the colonisation by arbuscular mycorrhizal fungi (AMF). The AMF develop unique structures within root cells: (**b**) vesicles with storage function, and (**c**) arbuscules, the typical brush-like structure which gives the name to this group of fungi. (SLS, MBR)

Diamonds of cuisine

- Mycorrhizas are among the most widespread symbionts in the world. They are found in more than 80 % of all plant species and 92 % of all plant families.
- Mycorrhizas can be managed as biofertilisers as they increase plant nutrient uptake (see pages 98-99).

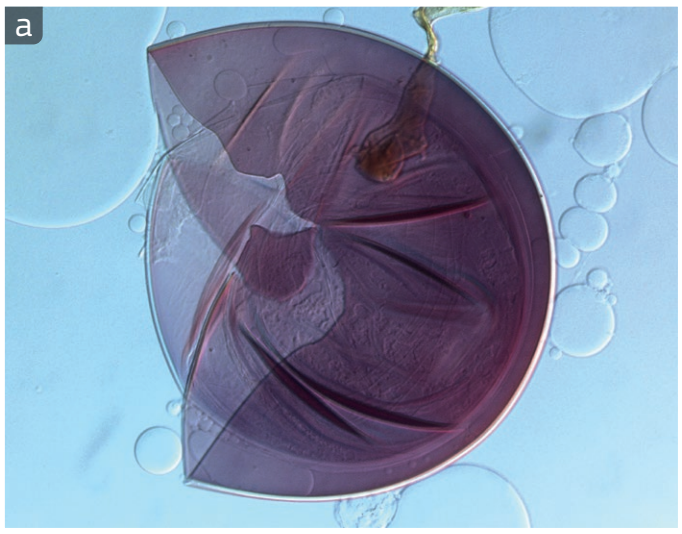
- Many species of ectomycorrhizal fungi are important culinary mushrooms and truffles.

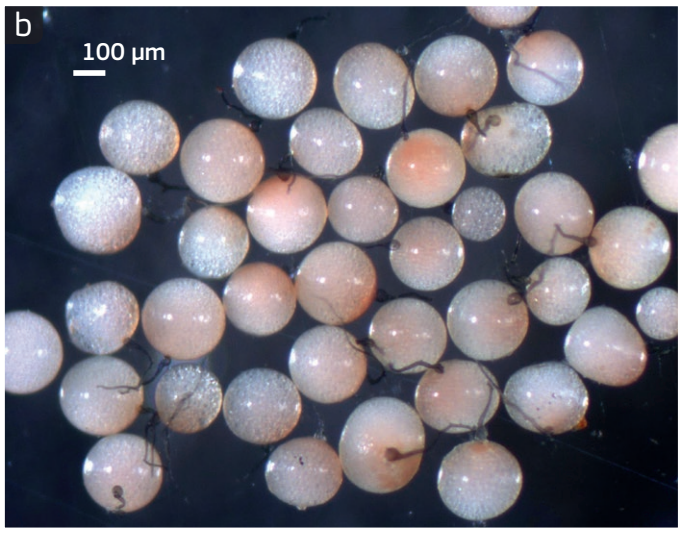
They look like potatoes but are mycorrhizal fungi. The white truffle (*Tuber magnatum*), known as the diamond of cuisine, is a prized ingredient for cooking. (AO)

The significant mutual benefit of mycorrhizal symbioses is evident from their tremendous abundance and diversity. Mycorrhizal fungi are found in all terrestrial biomes and in association with most plant families. They are found with trees, shrubs, forbs, grasses and agricultural crops. Arbuscular mycorrhizas are abundant in tropical forests, grasslands, savannahs, deserts and arable lands, and ectomycorrhizas dominate temperate and boreal forests. Ericaceous mycorrhizas are common in boreal forests and heathlands. Orchid mycorrhizas are essential to the survival of orchids throughout the world.

Glomeromycota

Fungi in the phylum Glomeromycota form arbuscular mycorrhizal symbioses with the majority of plant species, by colonising the root cortex (see box, page 43) and forming an extensive mycelium, vesicles and arbuscules. This phylum contains 17 genera and 240 species distributed in nine families and four orders. Common genera include *Glomus*, *Rhizopaghus*, *Sclerocystis*, *Gigaspora*, *Scutellospora*, *Cetraspora* and *Acaulospora*. Glomeromycota produce abundant hyphae and spores in soils. In grasslands and agricultural lands, these fungi comprise an estimated 20-30 % of soil microbial biomass, making arbuscular mycorrhizal fungi among the most abundant organisms in many soils.





Arbuscular mycorrhizal fungi reproduce through spores that can have various dimensions and colours: (**a**) a broken spore of *Cetraspora pellucida*, (**b**) the rosy spores of *Gigaspora rosea*, and (**c**) structures producing spores (sporocarps) of the fungus *Sclerocystis coremioides* associated with mosses. (SLS, KK)

Ectomycorrhizas

Approximately 6 000 fungal species establish ectomycorrhizal associations with many species of trees and woody plants. At least 20 families of Basidiomycota (e.g. Amanitaceae, Russulaceae, Boletaceae) and seven families of Ascomycota (e.g. Pezizaceae, Tuberaceae) are known to establish ectomycorrhizas. The biomass of ectomycorrhizal fungi mycelia has been estimated to range from 700 to 900 kg per hectare, and 20-40 % of an ectomycorrhizal root weight is due to the fungus.

Some of the fungi that are found in woodlands are ectomycorrhizal: (**a**) *Boletus bicolour*, and (**b**) *Scleroderma aurantium*. (MW)

Short lateral roots of a beech tree colonised by a white layer of hyphae of the ectomycorrhizal fungus *Xerocomus pruinatus*. (MB)

Ericaceous and orchid mycorrhizas

Most plant species belonging to Ericaceae, including the genera *Rhododendron*, *Calluna* and *Vaccinium*, form ericoid mycorrhizas. These plants form delicate roots lacking root hairs and their outermost radical cells become heavily colonised by Ascomycota from the genera *Rhizoscyphus* and *Hymenoschyphus*. Orchid mycorrhizas are established between plant species of the family Orchidaceae (20 000 to 35 000 species) and several groups of fungi in the phylum Basidiomycota, as well as some rare Ascomycota.

Plants belonging to Ericaceae, like heather (*Calluna vulgaris*) and Orchidaceae, may form specific fungal symbioses called ericaceous and orchid mycorrhizas, respectively. (RH)