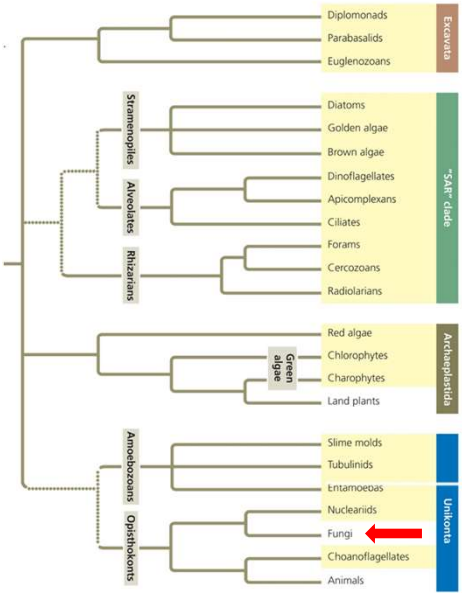
SLE 132 – Form and Function
Fungi and Lichens

DEAKIN COLLEGE in association with DEAKIN UNIVERSITY AUSTRALIA

Fungi

- Diverse and widespread kingdom
- Eukaryotic
  - Most have a cell wall composed of chitin
- **Diversity of lifestyles:** Decomposers, mutualists, parasitic

https://www.youtube.com/watch?v=7TI_scW0jBU (5 mins)



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Fungi

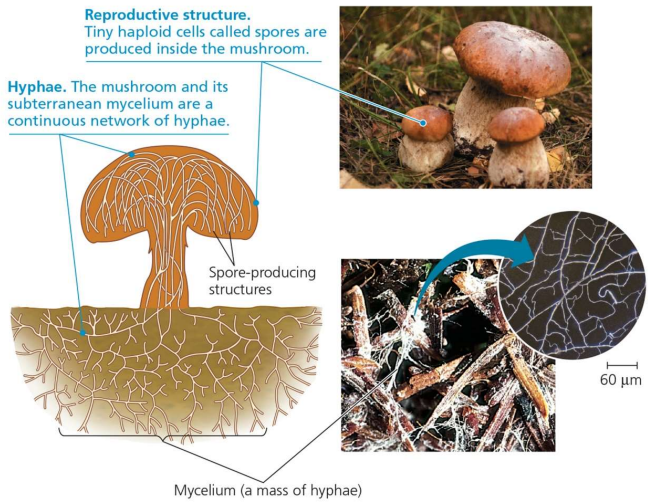
- **Heterotrophic**
  - Digest externally (secrete digestive enzymes to breakdown complex molecules into smaller organic compounds)
- Ecologically important role as **decomposers**
  - Essential for breaking down dead organic material and returning nutrient to the environment.
  - Mutualistic relationships benefit plants

Fungi

- Fungi **can conflict** with human interest
  - Attacks and breaks down cloth, paint, cartons, leather, insulation, cables & wires, optics, food
  - can produce toxins or act as pathogens
- But Fungi can also be very **useful**
  - Yeasts – brewing/baking, antibiotics, mycorrhizal associations etc.
  - Ecologically: returning nutrients (e.g. phosphorous and nitrogen) to the soil

Fungi Structure

- **Multicellular** (filamentous) and/or **single cellular** (yeast)
- Filamentous fungi are made up of thread-like **hyphae**
- The main body is called the **mycelium** (network of hyphae)

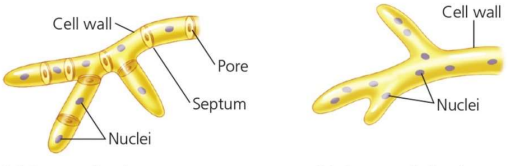


▲ **Figure 31.2** **Structure of a multicellular fungus.** The top photograph shows the sexual structures, in this case called mushrooms, of the penny bun fungus (*Boletus edulis*). The bottom photograph shows a mycelium growing on fallen conifer needles. The inset SEM shows hyphae.

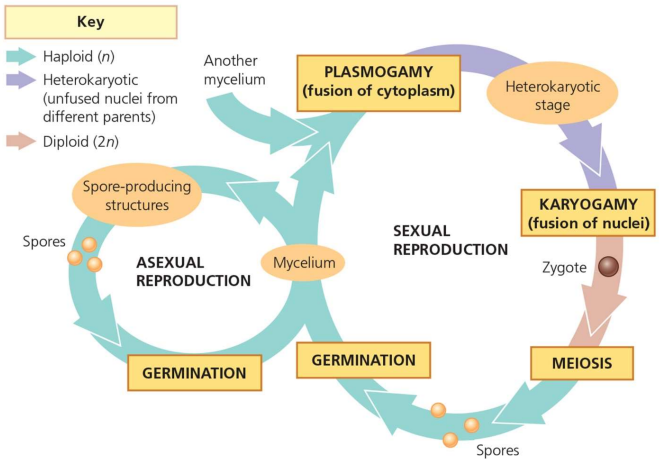
? *Although the mushrooms in the top photograph appear to be different individuals, could their DNA be identical? Explain.*

Reproduction

Fungi propagate by producing vast numbers of spores, either **sexually or asexually**



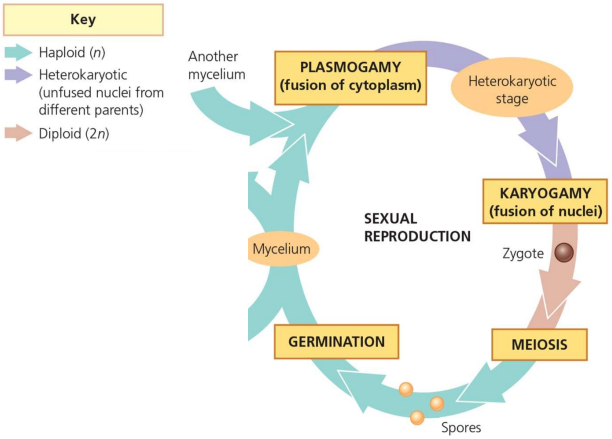
▲ **Figure 31.3** **Two forms of hyphae.**



▲ **Figure 31.5** **Generalised life cycle of fungi.** Many—but not all—fungi reproduce both sexually and asexually. Some reproduce only sexually, others only asexually.

Fungal – Sexual Life Cycle

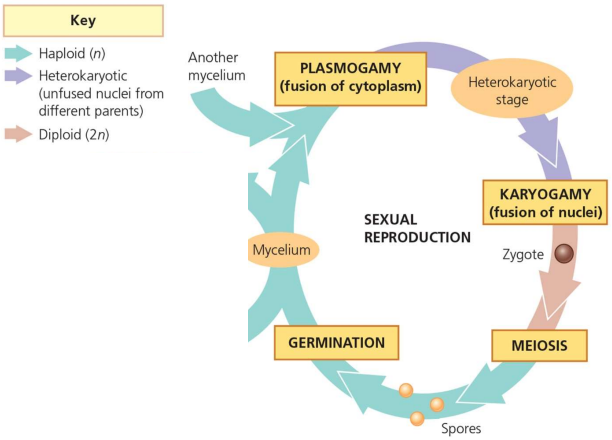
- Fungal nuclei are normally **haploid**, with the exception of transient **diploid stages** formed during the sexual life cycles
- Most species reproduce both asexually and sexually
- Sexual reproduction requires the fusion of hyphae from different mating types
- Fungi use sexual signaling molecules called pheromones to communicate their mating type
- **Plasmogamy** is the union of two parent **mycelia** (fusion of cytoplasm)



▲ **Figure 31.5** **Generalised life cycle of fungi.** Many—but not all—fungi reproduce both sexually and asexually. Some reproduce only sexually, others only asexually.

Fungal – Sexual Life Cycle

- In most fungi, the haploid nuclei from each parent do not fuse right away; they coexist in the mycelium, called a **heterokaryon** (heterokaryotic)
- Hours, days, or even centuries may pass before the occurrence of **karyogamy**, nuclear fusion
- During karyogamy, the haploid nuclei fuse, producing diploid cells
- The diploid phase is short-lived and undergoes meiosis, producing haploid spores

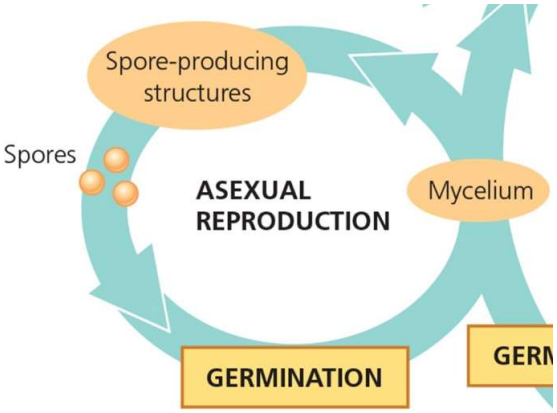


▲ **Figure 31.5** **Generalised life cycle of fungi.** Many—but not all—fungi reproduce both sexually and asexually. Some reproduce only sexually, others only asexually.

Fungal – Asexual reproduction

- Many fungi can reproduce asexually
- Mould produce haploid spores by mitosis
  and form visible mycelia

- Yeasts (single cellular):
  cell division or
  pinching of "bud cells"
  off parent cell



Fungi - Taxonomy

There are five main groups for Fungi

- **Zygomycota** (moulds)
- **Ascomycota** (yeasts, sac fungi) – marine, freshwater and terrestrial habitats
- **Basidomycota** (mushrooms/toadstools)
- **Chyrtrids** - lakes, soil, thermal vent habitats
- **Glomeromycetes**
  (many mycorrhizae with plant roots)

▶ *Tuber melanosporum* is a truffle species that forms ectomycorrhizae with trees. The ascocarp grows underground and emits a strong odour. These ascocarps have been dug up and the middle one sliced open.

◀ The edible ascocarp of *Morchella esculenta*, the tasty morel, is often found under trees in orchards.

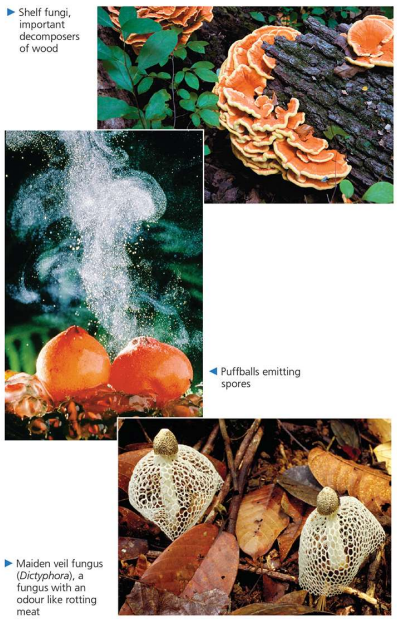
▲ **Figure 31.15** **Ascomycetes (sac fungi).**

? *Ascomycetes vary greatly in morphology (see also Figure 31.10). How could you confirm that a fungus is an ascomycete?*

▲ **Figure 31.19** **A fairy ring.** According to legend, mushroom rings spring up where fairies have danced on a moonlit night. The text provides a biological explanation of how these rings form.

Basidiomycota

- 25 000 species known
  - Mushrooms
  - Puffballs
  - Toadstools
  - Shelf fungi

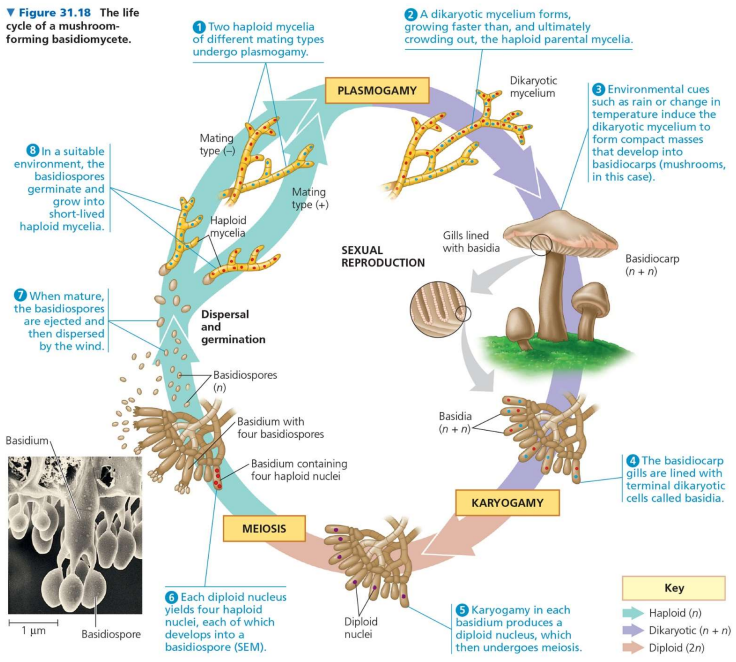


▲ **Figure 31.17** Basidiomycetes (club fungi).

Basidiomycota

In response to environmental stimuli, the mycelium reproduces sexually by producing elaborate fruiting bodies call basidiocarps
  - Mushrooms are examples of **basidiocarps**

The numerous **basidia** in a **basidiocarp** are sources of sexual spores called **basidiospores**



Define the following terms:

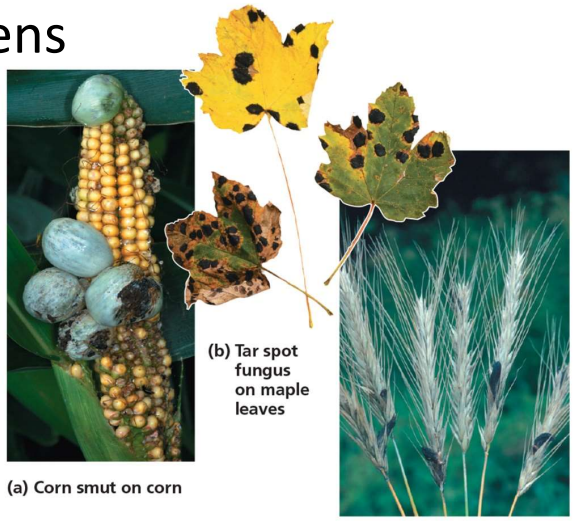
- Hyphae
- Mycelium
- Plasmogamy
- Karyogamy
- Basidiocarp
- Basidiomycota

Mutualistic relationships

- Fungi form mutualistic relationships with plants, algae, cyanobacteria and animals
- **Mycorrhizae** are mutualistic relationships between fungi and plant roots
- Mycorrhizae are very important in natural ecosystems and agriculture
- Fungus gains sugar from the host plant, host plant benefits from increased surface area for water uptake and mineral absorption

Pathogens

- About 30% of known fungal species are parasites or pathogens
- Mostly on or in plants
- Some fungi attack good crops that are toxic to humans



▲ **Figure 31.24** Examples of fungal diseases of plants.

Quick Question

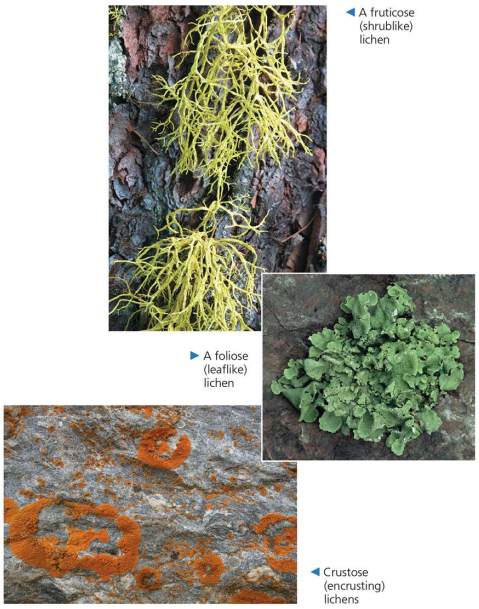
1. Like plants, fungi have _____; however in plants they are composed of_____ whereas in fungi they are composed of_____

A. Cell walls… phospholipids….cellulose
B. Cell membrane……phospholipid……chitin
C. Cell walls….. Cellulose……peptidoglycan
D. Cell walls…. Cellulose……chitin

Lichens

- A lichen is a symbiotic association between:
  - a **photosynthetic microorganism** (an algae or cyanobacteria)
  - **a fungus**
- Millions of photosynthetic cells are held in a mass of fungal hyphae

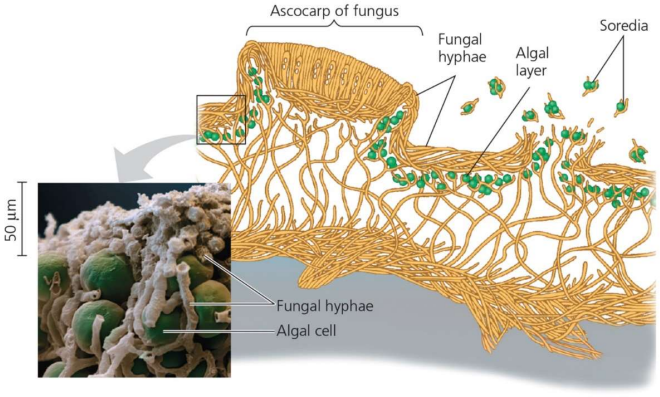
https://www.youtube.com/watch?v=Fkw_VF5zDT0



▲ **Figure 31.22** **Variation in lichen growth forms.**

Lichens

- The fungal component of a lichen is most often an **Ascomycete** (sac fungi) – <u>provide protective environment</u> for algae/ cyanobacteria
- Algae or cyanobacteria occupy an inner layer below the lichen surface – <u>provides sugars</u> (and fixes nitrogen if cyanobacteria)



▲ **Figure 31.23** **Anatomy of an ascomycete lichen** (colourised SEM).

Role of Lichens

- Lichens form **part of the food web** and are eaten by invertebrates and reindeer
- Can **provide shelter** for invertebrates and nesting material for birds
- Lichens help to **prevent soil erosion** and can form a crust on the soil
- Lichens can **promote soil production** by adding organic matter and nutrients to the soil by decay and or chemical erosion of rock
- Some lichens contain cyanobacteria which **can fix nitrogen**

Monitoring value of Lichens

- Lichens are important **biomonitors** (biological organisms that reflects the state of the environment over a prolonged period)

Desertification – satellite imagery used by CSIRO to detect the presence of lichen crusts can determine if an area has been disturbed

Forest dieback – is indicated by abnormal lichen growths

Indicator species – indicate forest health

Air pollution – lichens take in moisture from atmosphere and do not grow in polluted areas

Potential uses for Lichens

- Secondary compounds are common in lichens and many have antibiotic effects
- Some are used as sunblocks as they have high UV absorption
- Certain lichen polysaccharides have anti-tumour, anti-viral or anti-inflammatory effects

Distribution

- Very Few Lichens are endemic as reproductive bodies are small and can be carried into the atmosphere – thus have **world wide distribution**
- Factors limiting distribution are ecological – lichens will grow provided conditions are suitable
- Growth rates are slow
- Lichen studies are few – especially in Australia