



# Fungi

There are around 50,000 species of fungi including the moulds that are found on decaying vegetation. As well as larger fungi such as mushrooms, there are also mildews, smuts, rusts and many other plant disease-causing fungi. Some fungi can also cause disease in humans and animals.

## What are fungi?

Fungi differ fundamentally from green plants in that they do not need light in order to grow. Instead they live on dead organic matter or as parasites on living organisms. All fungi require for growth is a readily available food source, undisturbed water and time. Fungi reproduce by the production of spores that are easily transported via air. Spores will germinate if they land on a suitable surface with adequate moisture present. Fungi may have a characteristic and unpleasant odor (mouldy smell).

## Where do fungi grow?

Fungi will grow anywhere there is a source of food and continuous moisture. Some species are very specific and will only grow in certain places. Most indoor environments contain airborne fungal spores and levels are normally influenced by outdoor concentrations. The most common species found in buildings belong to the genera *Cladosporium*, *Penicillium*, *Alternaria*, *Aspergillus*, *Eurotium* and *Wallemia*.

The presence of fungi may be identified visually on suitable surface materials and by an unpleasant odour (mouldy smells). Fungi usually do not grow rapidly indoors or in large amounts if the environment is clean and dry. However, if the environment is damp high levels of airborne spores can be generated. Condensation is the principal source of moisture that promotes growth of fungi on the internal surfaces of domestic dwellings. Other factors (such as daily variation of light and temperature) can affect spore formation and growth.

Fungi grow outdoors wherever continuous moisture is present. Soil-borne fungi are essential for the decay of plant and animal matter. As such, compost heaps and potting composts can contain extremely high numbers

of fungal spores, including *Aspergillus fumigatus* that can cause allergy or aspergillosis. Fungi also grow in stored grain and can reach very high levels if grain moisture is above certain thresholds. Conditions are also ideal for fungal growth in many caves and underground pipes.

Some fungi are parasitic, that is they rely on living organisms as a food source. Some parasitic fungi cause infection in humans or animals. Other fungi are symbiotic meaning they have a close relationship with other organisms, such as in lichens.

## What are the health effects of fungi?

Fungi can cause human disease in three ways:

### 1. Infection

It is uncommon for environmental mould to cause an infection in healthy individuals. Infection is more likely to occur in individuals who have a severe reduction in immune function (e.g. after bone marrow transplant, cancer treatment, AIDS or major burns). Infections by some species such as *Aspergillus* species (aspergillosis) may be life threatening.

Exposure to fungi associated with bird or bat droppings, or soil contaminated by bird droppings, (e.g. *Histoplasma capsulatum* and *Cryptococcus neoformans*) can lead to flu-like illnesses in healthy persons or more severe effects in immuno-suppressed persons. Some fungi are pathogenic in humans such as the fungus *Trichophyton interdigitale* that causes athlete's foot and *Candida* species that cause thrush.

### 2. Allergic reaction

Due to the presence of allergens on spores it appears that all moulds have the potential to cause an allergic reaction in susceptible

humans. Mould growth in buildings is associated with an increased prevalence of respiratory symptoms and diseases, such as asthma and bronchitis.

The symptoms most commonly observed are: sore throat, runny nose, hoarseness, cough, headache, fever, hay fever, fatigue and hypersensitivity pneumonitis (HP). HP is also commonly known as Farmer's Lung Disease. HP becomes more severe with repeated exposure and can result in permanent lung damage or even death.

Another reaction, Organic Dust Toxic Syndrome (ODTS) produces an abrupt onset of flu-like symptoms and a burning sensation in the eyes and throat and can follow a single exposure to large amounts of fungus-contaminated dust. ODTS usually lasts 2-3 days and does not generally result in permanent damage.

There are no exposure limits for exposure to air-borne fungi. Because of the variation in susceptibility of individuals to fungi and the diverse nature of fungi and their health effects there are no "safe" levels of exposure. However it is generally believed that small amounts of mould growth, like those commonly found on shower walls, pose no immediate health risk to most individuals.

### **3. Toxins**

Many common fungi produce compounds known as mycotoxins. Some mycotoxins can cause serious illness in people or animals, usually by ingestion of mould-contaminated foods or toadstools. Fortunately, this is uncommon, as the toxins are generally not present in sufficient quantities to cause symptoms. In addition, mycotoxins are relatively large and non-volatile molecules so direct contact is required. The fungus *Stachybotrys chartarum* (also known as *S. atra* and *S. alternans*) is sometimes found in buildings and produces mycotoxins that can cause haem-orrhaging in animals although it is not clear whether it produces symptoms in humans.

## **Occupational Exposure**

The main health risk from occupational exposure is from inhalation of organic dusts containing fungal spores that can cause respiratory symptoms. Therefore, workers handling fungi contaminated materials must take safety measures to prevent risk of exposure to fungi. Occupations with the highest risk of exposure are:

### ➤ **Farm workers**

Grain, silage, hay and other organic materials may become contaminated with fungi when stored in conditions that favour growth, such as grain stored at greater than 13% moisture content. Inhalation of spores may cause asthma, allergy, chronic bronchitis, hypersensitivity pneumonia (also known as farmer's lung disease) and ODTS. *Aspergillus* species are the major problem in stored grain. Risk of exposure is greatest when working with mouldy grain, hay or silage in closed environments such as grain bins and barns. Wet harvesting conditions also favour fungal growth and workers are then at risk when harvesting, transporting and drying grains.

### ➤ **Horticulture workers & landscape gardeners**

A common mould, *Aspergillus fumigatus* which grows strongly on self-heating compost, can liberate vast numbers of spores that are able to penetrate deeply into the respiratory system. In this case spores may not only bring about an allergic reaction but may also germinate in the lung resulting in Aspergillosis. This is mainly a problem in farm animals but can also affect humans. Asthma is also a problem, particularly among those who work in glasshouses with tomatoes heavily attacked by *Cladosporium fulvum*.

### ➤ **Indoor workers**

Floods, leaking pipes, leaking windows or roofs, inadequate ventilation or improper drying of flooded areas are all potential sources of moisture that can lead to fungal growth. The presence of moisture in buildings favours the growth of moulds on surfaces that can cause high levels of airborne spores that may cause allergic reactions or respiratory problems. Air conditioning filters that do not fit correctly or are not properly maintained become ineffective at filtering out fungal spores. Sick Building Syndrome has a variety of possible causes including inhalation of fungal spores. More information on Sick Building Syndrome can be found in our fact sheet on the subject.

### ➤ **People who work with animals**

People who work with domestic or farm animals may become infected with fungal diseases such as ringworm that can be transmitted from animals.

### ➤ **Construction and demolition workers**

The demolition of mouldy structures can involve very high exposures to airborne fungi. This can result in ODS or other respiratory problems. High moisture levels from leakages, seepage and rainfall favour the growth of moulds on construction sites, particularly in underground areas.

## Assessing fungal contamination

The working environment can be monitored for airborne microbial agents to identify the presence and nature of potential health hazards. Monitoring also allows the level of risk to workers and the public to be assessed and ensures that concentrations of airborne organisms are maintained below an acceptable level. The presence of fungal contamination is determined by visual inspection and sampling to identify and determine levels of airborne fungi. Indoor air samples must be compared with outdoor samples to determine if a problem exists. Where indoor concentrations are higher than outdoor then indoor sources of fungi probably exist and should be controlled. The composition of fungal species should also be compared with outdoors and samples taken from other uncontaminated buildings. The presence of certain species of organisms is an indicator that action should be taken: *Aspergillus fumigatus*, *A. versicolor*, *Trichoderma*, *Exophiala*, *Stachybotrys*, *Phialophora*, *Fusarium*, *Ulocladium*, yeasts, *Eurotium*, *Wallemia*, *Penicillium chrysogenum* and *P. aurantiogriseum*.

### ➤ **Visual Inspection**

Contaminant sources of fungi can be initially assessed by visual inspection of likely reservoirs, for example dirty filters in air-conditioning plants, damp carpets or mouldy walls in buildings, etc.

### ➤ **Sampling**

Airborne samples can be collected in a number of ways, either by impacting onto a surface or impinging into a liquid. Samples are sent to the laboratory for analysis. Settling plates used for sampling fungi are usually measured over 15 minutes. Surface samples, in the form of bulk samples, cultural swabs or tape samples, are used to confirm and identify contaminant fungi. This must be performed by a suitably qualified industrial hygienist.

## Prevention and control in buildings

Various measures can be followed to minimize or eliminate fungal growth indoors. Once a microbial problem has been identified it should be remedied as soon as possible.

### **In the general environment**

- Reduce the moisture level availability. Relative humidity must be kept less than 70%.
- Improve ventilation. Airborne fungi and their metabolites may be concentrated indoors due to insufficient ventilation.
- Vapour barriers and good insulation of surface building can minimize fungi growth. Smooth, non-porous surfaces do not favor fungal growth and an anti-fungal agent can be used in paint to protect surfaces.
- Clean up water spills promptly. Flooded areas must be cleaned and dried thoroughly - professional cleaning may be required.
- Porous materials (e.g. paper, cardboard, gyprock) that are water damaged or contaminated with fungi should be disposed of where possible.

### **In air conditioning**

- Clean the filters of the air-conditioning system on a regular basis. Prevent accumulation of dust, bacteria or fungi growth.
- Keep the system in a well-ventilated environment and minimize the humidity of the system.
- Remove and prevent stagnant water.
- HEPA filters should be installed at the intake panel and cleaned or replaced regularly.

## Cleaning and disinfecting

The following steps should be taken if there is a fungi problem:

- If an area is heavily contaminated with fungi, it should be isolated with a high polythene sheet barrier and occupants should be moved away from the area until removal or cleaning of contaminants. It may be preferable to enlist a professional cleaning company.

- All contaminated materials should be sealed in plastic bags before removal from the area. This includes filters, disposable protective clothing etc.
- If possible, remove and discard all contaminated items on which fungi have grown. Often, residual fungi may re-grow if the condition returns.
- If the items have to be kept, clean and disinfect the items with a safe, appropriate agent.
- Wash the surface with bleach (sodium hypochlorite) other suitable disinfectant.
- Throughout removal work, maintain good natural ventilation.
- Personal protective equipment such as respirator, goggles, gloves should be worn.

A disposable P1 mask is sufficient for lower levels of contamination; however, in areas of extensive contamination a full-face mask (or half mask with eye protection) with HEPA filter should be worn along with disposable protective clothing.

- People who have pre-existing asthma, allergy or immuno-suppressed disorder should avoid fungi removal and cleaning tasks.

Measures should be taken to prevent the spread of the contamination during cleaning or removal. For areas of extensive contamination all openings such as ventilation ducts should be sealed off using plastic sheeting and duct tape to prevent the spread of the fungi. If possible an exhaust fan with an HEPA filter should be used (note: do not use an exhaust fan without a filter). Dust suppression methods such as misting of surfaces are recommended.

**For further information and advice contact the Workers Health Centre**

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