

# Mold health issues

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**Mold health issues** are potentially harmful effects of molds.

Molds (US usage; British English "moulds") are ubiquitous in the biosphere, and mold spores are a common component of household and workplace dust. The United States Centers for Disease Control and Prevention reported in its June 2006 report, 'Mold Prevention Strategies and Possible Health Effects in the Aftermath of Hurricanes and Major Floods,' that "excessive exposure to mold-contaminated materials can cause adverse health effects in susceptible persons regardless of the type of mold or the extent of contamination."<sup>[1]</sup> When mold spores are present in abnormally high quantities, they can present especially hazardous health risks to humans, including allergic reactions or poisoning by mycotoxins,<sup>[2]</sup> or causing fungal infection (mycosis).



Light micrograph of the hyphae and spores of the human pathogen *Aspergillus fumigatus*

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## Health effects

Studies have shown that people who are atopic (sensitive), already suffer from allergies, asthma, or compromised immune systems<sup>[3]</sup> and occupy damp or moldy buildings are at an increased risk of health problems such as inflammatory and toxic responses to mold spores, metabolites and other components.<sup>[4]</sup> The most common health problem is an allergic reaction. Other problems are respiratory and/or immune system responses including respiratory symptoms, respiratory infections, exacerbation of asthma, and

rarely hypersensitivity pneumonitis, allergic alveolitis, chronic rhinosinusitis and allergic fungal sinusitis. Severe reactions are rare but possible. A person's reaction to mold depends on their sensitivity and other health conditions, the amount of mold present, length of exposure and the type of mold or mold products.

Some molds also produce mycotoxins that can pose serious health risks to humans and animals. The term "toxic mold" refers to molds that produce mycotoxins, such as *Stachybotrys chartarum*, not to all molds.

<sup>[5]</sup> Exposure to high levels of mycotoxins can lead to neurological problems and in some cases death.<sup>[6]</sup> Prolonged exposure, e.g., daily workplace exposure, can be particularly harmful.

The five most common genera of indoor molds are *Cladosporium*, *Penicillium*, *Aspergillus*, *Alternaria* and *Trichoderma*.

Damp environments which allow mold to grow can also produce bacteria and help release volatile organic compounds.

## Symptoms of mold exposure

Symptoms of mold exposure can include:<sup>[7]</sup>

- Nasal and sinus congestion, runny nose
- Respiratory problems, such as wheezing and difficulty breathing, chest tightness
- Cough
- Throat irritation
- Sneezing / Sneezing fits

## Health effects linking to asthma

Infants may develop respiratory symptoms as a result of exposure to a specific type of fungal mold, called *Penicillium*. Signs that an infant may have mold-related respiratory problems include (but are not limited to) a persistent cough and/or wheeze. Increased exposure increases the probability of developing respiratory symptoms during their first year of life. Studies have shown that a correlation exists between the probability of developing asthma and increased exposure to *Penicillium*. The levels are deemed 'no mold' to 'low level' , from 'low' to 'intermediate' , and from 'intermediate' to 'high'.<sup>[8]</sup>

Mold exposures have a variety of health effects depending on the person. Some people are more sensitive to mold than others. Exposure to mold can cause a number of health issues such as; throat irritation, nasal stuffiness, eye irritation, cough and wheezing, as well as skin irritation in some cases. Exposure to mold may also cause heightened sensitivity depending on the time and nature of exposure. People at higher risk for mold allergies are people with chronic lung illnesses, which will result in more severe reactions when exposed to mold.

There has been sufficient evidence that damp indoor environments are correlated with upper respiratory tract symptoms such as coughing, and wheezing in people with asthma.<sup>[9]</sup>

## Mold-associated conditions

Health problems associated with high levels of airborne mold spores include<sup>[10]</sup> allergic reactions, asthma episodes, irritations of the eye, nose and throat, sinus congestion, and other respiratory problems, although it should be noted that mold spores won't actually cause asthma, just irritate existing conditions. For example, residents of homes with mold are at an elevated risk for both respiratory infections and bronchitis.<sup>[11]</sup> When mold spores are inhaled by an immunocompromised individual, some mold spores may begin to grow on living tissue,<sup>[12]</sup> attaching to cells along the respiratory tract and causing further problems.<sup>[13][14]</sup> Generally, when this occurs, the illness is an epiphenomenon and not the primary pathology. Also, mold may produce mycotoxins, either before or after exposure to humans, potentially causing toxicity.

## Fungal infection

A serious health threat from mold exposure for immunocompromised individuals is systemic fungal infection (systemic mycosis). Immunocompromised individuals exposed to high levels of mold, or individuals with chronic exposure may become infected.<sup>[15][16]</sup> Sinuses and digestive tract infections are most common; lung and skin infections are also possible. Mycotoxins may or may not be produced by the invading mold.

Dermatophytes are the parasitic fungi that cause skin infections such as athlete's foot and tinea cruris. Most dermatophyte fungi take the form of a mold, as opposed to a yeast, with appearance (when cultured) that is similar to other molds.

Opportunistic infection by molds<sup>[17]</sup> such as *Penicillium marneffei* and *Aspergillus fumigatus* is a common cause of illness and death among immunocompromised people, including people with AIDS or asthma.<sup>[18][19]</sup>

## Mold-induced hypersensitivity

The most common form of hypersensitivity is caused by the direct exposure to inhaled mold spores that can be dead or alive or hyphal fragments which can lead to allergic asthma or allergic rhinitis.<sup>[20]</sup> The most common effects are rhinorrhea (runny nose), watery eyes, coughing and asthma attacks. Another form of hypersensitivity is hypersensitivity pneumonitis. Exposure can occur at home, at work or in other settings.<sup>[20][21]</sup> It is predicted that about 5% of people have some airway symptoms due to allergic reactions to molds in their lifetimes.<sup>[22]</sup>

Hypersensitivity may also be a reaction toward an established fungal infection in allergic bronchopulmonary aspergillosis.

## Mycotoxin toxicity

Molds excrete toxic compounds called mycotoxins, secondary metabolites produced by fungi under certain environmental conditions. These environmental conditions affect the production of mycotoxins at the transcription level. Temperature, water activity and pH, strongly influence mycotoxin biosynthesis by

increasing the level of transcription within the fungal spore. It has also been found that low levels of fungicides can boost mycotoxin synthesis.<sup>[23][24]</sup> Certain mycotoxins can be harmful or lethal to humans and animals when exposure is high enough.<sup>[25][26]</sup>

Extreme exposure to very high levels of mycotoxins can lead to neurological problems and in some cases death; fortunately, such exposures rarely to never occur in normal exposure scenarios, even in residences with serious mold problems. Prolonged exposure, such as daily workplace exposure, can be particularly harmful.

The health hazards produced by mold have been associated with sick building syndrome, but no validated studies have been able to demonstrate that normal indoor exposures to these common organisms pose a significant threat.

It is thought that all molds may produce mycotoxins and thus all molds may be potentially toxic if large enough quantities are ingested, or the human becomes exposed to extreme quantities of mold. Mycotoxins are not produced all the time, but only under specific growing conditions. Mycotoxins are harmful or lethal to humans and animals only when exposure is high enough.

Mycotoxins can be found on the mold spore and mold fragments, and therefore they can also be found on the substrate upon which the mold grows. Routes of entry for these insults can include ingestion, dermal exposure and inhalation.

Some mycotoxins cause immune system responses that vary considerably, depending on the individual. The duration of exposure, the frequency of exposure and the concentration of the insult (exposure) are elements in triggering immune system response.

Aflatoxin is an example of a mycotoxin. It is a cancer-causing poison produced by certain fungi in or on foods and feeds, especially in field corn and peanuts.<sup>[27]</sup>

Originally, toxic effects from mold were thought to be the result of exposure to the mycotoxins of some mold species, such as *Stachybotrys chartarum*. However, studies are suggesting that the so-called toxic effects are actually the result of chronic activation of the immune system, leading to chronic inflammation. Studies indicate that up to 25% of the population have the genetic capability of experiencing chronic inflammation to mold exposure, but it is unknown how many actually experience such symptoms due to frequent misdiagnosis. A 1993–94 case study based on cases of pulmonary hemorrhage in infants in Cleveland, Ohio originally concluded there was causal relationship between the exposure and the disease. The investigators revisited the cases and established that there was no link to the exposure to *S. chartarum* and the infants in their homes.

The common house mold, *Trichoderma longibrachiatum*, produces small toxic peptides containing amino acids not found in common proteins, like alpha-aminoisobutyric acid, called trilongins (up to 10% w/w). Their toxicity is due to absorption into cells and production of nano-channels that obstruct vital ion channels that ferry potassium and sodium ions across the cell membrane. This affects in the cells action potential profile, as seen in cardiomyocytes, pneumocytes and neurons leading to conduction defects. Trilongins are highly resistant to heat and antimicrobials making primary prevention the only management option.<sup>[28][29][30]</sup>

## Exposure sources and prevention

The main sources of mold exposure are from the indoor air in buildings with substantial mold growth, and from ingestion of food with mold growths.

### Air

Prevention of mold exposure and its ensuing health issues begins with prevention of mold growth in the first place by avoiding a mold-supporting environment such as humid air. Extensive flooding and water damage can support extensive mold growth. Following hurricanes, homes with greater flood damage, especially those with more than 3 feet (0.91 m) of indoor flooding, demonstrated higher levels of mold growth compared with homes with little or no flooding.<sup>[31][32]</sup> The aftermath of a hurricane is the worst-case scenario, but the concept of water damage supporting widespread mold growth is more generally applicable.

It is useful to perform an assessment of the location and extent of the mold hazard in a structure. Various practices of remediation can be followed to mitigate mold issues in buildings, the most important of which is to reduce moisture levels.<sup>[33]</sup> Removal of affected materials after the source of moisture has been reduced and/or eliminated may be necessary.<sup>[34]</sup> Thus, the concept of mold growth, assessment, and remediation is essential in prevention of mold health issues.

A common issue with mold hazards in the household is the placement of furniture, and the lack of ventilation which this causes to certain parts of the wall. The simplest method of avoiding mold in a home so affected is to move the furniture in question.

Adverse respiratory health effects are associated with occupancy in buildings with moisture and mold damage.<sup>[35]</sup>

Molds may excrete liquids or low-volatility gases, but the concentrations are so low that frequently they cannot be detected even with sensitive analytical sampling techniques. Sometimes these by-products are detectable by odor, in which case they are referred to as "ergonomic odors" meaning the odors are detectable, but do not indicate toxicologically significant exposures.

### Food

Molds that are often found on meat and poultry include members of the genera *Alternaria*, *Aspergillus*, *Botrytis*, *Cladosporium*, *Fusarium*, *Geotrichum*, *Mortierella*, *Mucor*, *Neurospora*, *Paecilomyces*, *Penicillium* and *Rhizopus*.<sup>[36]</sup> Grain crops in particular incur considerable losses both in field and storage due to pathogens, post-harvest spoilage and insect damage. A number of common microfungi are important agents of post-harvest spoilage, notably members of the genera *Aspergillus*, *Fusarium* and *Penicillium*.<sup>[36]</sup> A number of these produce mycotoxins (soluble, non-volatile toxins produced by a range of microfungi that demonstrate specific and potent toxic properties on human and animal cells<sup>[37]</sup>) that can render foods unfit for consumption. When ingested, inhaled, or absorbed through skin, mycotoxins may cause or contribute to a range of effects from reduced appetite and general malaise to acute illness or death in rare cases.<sup>[38][39][40]</sup> Mycotoxins may also contribute to cancer. Dietary exposure to the mycotoxin

aflatoxin B1, commonly produced by growth of the fungus *Aspergillus flavus* on improperly stored ground nuts in many areas of the developing world, is known to independently (and synergistically with Hepatitis B virus) induce liver cancer.<sup>[41]</sup> Mycotoxin-contaminated grain and other food products have a significantly impact on human and animal health globally. According to the World Health Organization, roughly 25% of the world's food may be contaminated by mycotoxins.<sup>[38]</sup>

Prevention of mold exposure from food is generally to consume food that has no mold growths on it.<sup>[27]</sup> Also, mold growth in the first place can be prevented by the same concept of mold growth, assessment, and remediation that prevents air exposure. In addition, it is especially useful to clean the inside of the refrigerator, and to ensure dishcloths, towels, sponges and mops are clean.<sup>[27]</sup>

Ruminants are considered to have increased resistance to some mycotoxins, presumably due to the superior mycotoxin-degrading capabilities of their gut microbiota.<sup>[38]</sup> The passage of mycotoxins through the food chain may also have important consequences on human health.<sup>[42]</sup> For example, in China in December 2011, high levels of carcinogen aflatoxin M1 in Mengniu brand milk were found to be associated with the consumption of mold-contaminated feed by dairy cattle.<sup>[43]</sup>

## History

In the 1930s, mold was identified as the cause behind the mysterious deaths of farm animals in Russia and other countries. *Stachybotrys chartarum* was found growing on wet grain used for animal feed. Illness and death also occurred in humans when starving peasants ate large quantities of rotten food grains and cereals that were heavily overgrown with the *Stachybotrys* mold.

In the 1970s, building construction techniques changed in response to changing economic realities including the energy crisis. As a result, homes and buildings became more airtight. Also, cheaper materials such as drywall came into common use. The newer building materials reduced the drying potential of the structures making moisture problems more prevalent. This combination of increased moisture and suitable substrates contributed to increased mold growth inside buildings.

Today, the US Food and Drug Administration and the agriculture industry closely monitor mold and mycotoxin levels in grains and foodstuffs in order to keep the contamination of animal feed and human food supplies below specific levels. In 2005 Diamond Pet Foods, a US pet food manufacturer, experienced a significant rise in the number of corn shipments containing elevated levels of aflatoxin. This mold toxin eventually made it into the pet food supply, and dozens of dogs and cats died before the company was forced to recall affected products.<sup>[44][45]</sup>

## Litigation



Moldy nectarines that were in a refrigerator. The nectarine with black mold is also affecting the nectarine underneath.

In 2002, the U.S. International Trade Commission reported that according to one estimate, US insurers paid over \$3 billion in mold-related lawsuits, more than double the previous year's total.<sup>[46]</sup> According to the Insurance Information Institute, in 2003 there were over 10,000 mold-related lawsuits pending in US state courts.<sup>[47]</sup> Most were filed in states with high humidity, but suits were on the rise in other states as well.<sup>[47]</sup> By 2004, many mold litigation settlements were for amounts well past \$100,000.<sup>[48]</sup> In 2005, the U.S. International Trade Commission reported that toxic mold showed signs of being the "new asbestos" in terms of claims paid.<sup>[46]</sup> In 2012, a key appellate court in Manhattan found a consensus in the scientific literature for a causal relationship between the presence of mold and resultant illness.<sup>[49]</sup>

In 1999, an Austin, Texas, woman was awarded \$32 million when she sued her insurer over mold damage in her 22-room mansion.<sup>[48]</sup>

In 2001, a jury awarded a couple and their eight-year-old son \$2.7 million, plus attorney's fees and costs, in a toxic mold-related personal injury lawsuit against the owners and managers of their apartment in Sacramento, California.<sup>[50]</sup>

In 2003, *The Tonight Show* co-host Ed McMahon received \$7.2 million from insurers and others to settle his lawsuit alleging that toxic mold in his Beverly Hills home made him and his wife ill and killed their dog.<sup>[51]</sup> That same year environmental activist Erin Brockovich received settlements of \$430,000 from two parties and an undisclosed amount from a third party to settle her lawsuit alleging toxic mold in her Agoura Hills, California, home.<sup>[52]</sup>

In 2006, a Manhattan Beach, California family received a \$22.6 million settlement in a toxic mold case.<sup>[53]</sup> The family had asserted that that moldy lumber had caused severe medical problems in their child.<sup>[53]</sup> That same year, Hilton Hotels received \$25 million in settlement of its lawsuit over mold growth in the Hilton Hawaiian Village's Kalia Tower.<sup>[54]</sup>

In 2010, a jury awarded \$1.2 million in damages in a lawsuit against a landlord for neglecting to repair a mold-infested house in Laguna Beach, California.<sup>[55]</sup> The lawsuit asserted that a child in the home suffered from severe respiratory problems for several years as a result of the mold.<sup>[55]</sup>

In 2011, in North Pocono, Pennsylvania, a jury awarded two homeowners \$4.3 million in a toxic mold verdict.<sup>[56]</sup>

## See also

- Building biology
- Environmental engineering
- Environmental health
- Occupational asthma
- Occupational safety and health

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## External links

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- CDC.gov Mold (<http://www.cdc.gov/mold/default.htm>)
- US EPA: Mold Information — U.S. Environmental Protection Agency (<http://www.epa.gov/mold/>)
- US EPA: EPA Publication #402-K-02-003 "A Brief Guide to Mold, Moisture, and Your Home" (<http://www.epa.gov/iaq/molds/moldguide.html>)
- NIBS: Whole Building Design Guide: Air Decontamination ([http://www.wbdg.org/design/air\\_decon.php](http://www.wbdg.org/design/air_decon.php))
- NPIC: Mold Pest Control Information — National Pesticide Information Center (<http://npic.orst.edu/pest2.htm#mold>)
- Mycotoxins in grains and the food supply:
  - indianacrop.org (<http://www.indianacrop.org/Mycotoxin.htm>)
  - cropwatch.unl.edu (<http://cropwatch.unl.edu/aflatoxin.html>)
  - agbiopubs.sdstate.edu (<http://agbiopubs.sdstate.edu/articles/FS907.pdf>) (PDF)

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