

## **Appendix A : Health Effects**

Several comprehensive reviews of the scientific literature on the health effects of mold in indoor spaces have been published in recent years.<sup>1-3</sup> This appendix reflects these reviews but has also considered more recently published articles.

### **Potential for Exposure and Health Effects**

Fungi are common in both indoor and outdoor environments and play a vital role in the earth's ecology by decomposing organic matter such as dead trees and leaves. As a result, all people have routine exposure to fungi, which may occur through inhalation, ingestion, and touching moldy surfaces. The main route of exposure to mold for people living or working in moldy indoor environments is inhalation of airborne fungal spores, fragments, or metabolites.<sup>2</sup> Ingestion and dermal exposures are less understood in these scenarios and can easily be minimized or prevented by workers through proper hygiene and work practices. Therefore, the remaining discussion will focus on the adverse health effects of mold due to inhalational exposure.

Adverse health effects may include: allergic reactions; toxic effects and irritation; and infections.<sup>1-5</sup> The mere presence of mold growth does not necessarily indicate that people present in the area will exhibit adverse health effects. However, as the amount of mold-impacted materials increases, so do potential exposures. Certain exposures may represent a significant risk such as occupational exposures to high concentrations of fungi and chronic (long-term) exposures, especially of individuals with underlying health conditions such as asthma, compromised immune systems, or allergies.

Evidence linking mold exposures to severe human health effects is documented in reports of occupational disease, particularly in forestry and agricultural settings where inhalation exposures were typically high and/or chronic.<sup>2,6-11</sup> The intensity of mold exposure and associated health effects experienced in undisturbed indoor environments is usually much less severe than that experienced by agricultural or forestry workers.<sup>2,7,12-14</sup> With the possible exception of exposures from mold remediation work, such high-level exposures are not expected indoors.<sup>15-16</sup> Although high-level exposures are unlikely to occur in undisturbed indoor settings, chronic exposures to lower levels may still raise health concerns.

Several factors influence the likelihood that individuals might experience health effects following exposure to mold in indoor environments. These include: the nature of the fungal material (e.g., allergenic, toxic/irritant, or infectious); the degree of exposure (amount and duration); and the susceptibility of exposed people. Susceptibility varies with genetic predisposition, age, state of health, concurrent exposures, and previous sensitization. It is not possible to determine "safe" or "unsafe" levels of exposure for the general public because of variation of individual susceptibility, lack of standardized and validated environmental exposure sampling methods, and lack of reliable biological markers. <sup>17</sup>

In addition to the adverse health effects associated with exposure to mold, in 2004, the Institute of Medicine (IOM) reported health risks associated with living in damp indoor environments. The IOM reported evidence suggesting an association between damp indoor environments and the development of asthma. Reported respiratory symptoms included, wheezing, coughing, and exacerbation of asthma.<sup>2</sup>

### **Allergic and Hypersensitivity Effects**

It is well established that fungi can cause allergic reactions in humans. The most common symptoms associated with allergic reactions include runny nose, sneezing, post-nasal drip with sore throat, eye irritation, cough, wheeze, and other symptoms associated with the aggravation of asthma.<sup>2,13,18-23</sup> Immunological responses to mold include allergic rhinitis, hypersensitivity pneumonitis, and asthma exacerbations. These conditions require prior exposure for sensitization. These symptoms may persist for some time after removal from the source.

Allergic rhinitis is a group of symptoms that mostly affects the mucous membranes of nasal passages and may result from an allergic reaction to fungi. Symptoms often associated with “hay fever” such as congestion, runny nose, and sneezing may occur.<sup>5,24</sup>

Hypersensitivity pneumonitis (HP) is a rare lung disease with delayed onset (3-8 hours) of fever, shortness of breath, cough, chest tightness, chills, and general malaise. With continued exposure, HP can lead to permanent lung disease. The occurrence of HP, even among those that are highly exposed to fungi, is rare. HP has typically been associated with repeated heavy exposures in forestry and agricultural settings, which raises concerns for workers routinely performing mold remediation, but has also been reported in indoor settings with lower level chronic exposures.<sup>3,11,18,25-27</sup>

Allergic bronchopulmonary aspergillosis (ABPA) and allergic fungal sinusitis (AFS) are examples of rarely occurring allergic reactions to non-invasive fungal growth in the respiratory system. Most symptoms are non-specific resembling asthma or chronic sinusitis. In addition, ABPA and AFS usually occur in those with underlying medical problems. In the case of ABPA, this includes cystic fibrosis, asthma, and other predisposing medical conditions.<sup>28,29</sup>

Recent studies, which have suggested an association between the presence of indoor mold and the development of asthma or allergies, are limited and difficult to interpret. Stark *et al.* found higher concentrations of dust-borne mold in infants’ homes were associated with development of allergic rhinitis, which is a known risk factor for childhood asthma.<sup>24</sup> However, other studies have shown higher concentrations of dust-borne fungi and other microorganisms in infants’ homes were associated with a *decreased* risk for asthma and wheezing.<sup>30,31</sup> Jaakkola *et al.* reported an association between a moldy odor in the home and development of asthma, but no association with visible mold or water damage was found. Although the sample size for this subset was small, it suggests that active mold growth might be a stronger risk factor for certain health effects than presence of nonviable or inactive mold alone.<sup>32</sup> This also is supported by recent studies that have shown allergen production is

significantly increased during active growth.<sup>33,34</sup>

Though available, allergy testing for molds is limited, subject to high rates of error, and can be difficult to interpret. Preparations for skin testing or the specific antigen in blood tests may be different from the mold to which an individual is sensitive. A positive test indicates an allergic response but does not definitively link a specific mold exposure to an individual's current health condition.<sup>5</sup>

## **Irritant and Toxic Effects**

### *Irritant Effects*

Indoor growth of mold can lead to the production of volatile organic compounds (VOCs), also referred to as microbial VOCs (MVOCs), and the presence of fungal glucans.<sup>13,35-38</sup> Glucans are components of many fungal cell walls. Some studies have reported an association with the inhalation of glucans and airway irritation and inflammation, but results have been mixed and may not be applicable to expected indoor concentrations. Observed effects may also be the result of exposure to or contact with other fungal components, metabolites, or synergistic effects with other microbial agents.<sup>17,36,39</sup> Resolution of irritant symptoms upon removal from the source can help distinguish irritant effects from allergic symptoms.<sup>5</sup>

MVOCs are responsible for the musty odor often associated with mold growth, which may be noticeable at very low concentrations. Many of the MVOCs are common to other sources in the home.<sup>40</sup> The very low levels usually found indoors have not been shown to cause health effects.<sup>35,37</sup>

### *Toxic Effects*

Some symptoms and maladies have been attributed to the toxic effects of fungi in indoor environments. Certain fungi can produce toxins (mycotoxins) at varying levels that are dependent on many complex environmental and biological factors.<sup>41</sup> The reported symptoms from exposure to mycotoxins indoors include headaches, irritation, and nausea/loss of appetite, but are often non-specific (*e.g.* fatigue, inability to concentrate/remember), and may be caused by other environmental and non-environmental agents.<sup>2,42-46</sup> Although health effects from exposures to mycotoxins have been associated with certain occupational exposures or ingestion of mold-contaminated food, scientific support for the reported effects in indoor environments has not been established. This may be due to the lower levels of exposure and different routes of exposure.<sup>2,5,13,21,27,46-49</sup>

*Stachybotrys* is colloquially referred to as “black mold” or “toxic mold.” It has been suggested that toxins produced by this mold are associated with specific health effects. Acute Idiopathic Pulmonary Hemorrhage (AIPH) in infants has been described in several reports suggesting a relationship with *Stachybotrys*. AIPH is an uncommon condition that results in bleeding in the lungs. The IOM reviewed the existing studies and concluded that there was insufficient

evidence to determine if mold exposure was associated with AIPH.<sup>2,3</sup> The evidence is also insufficient for an association between inhalation of *Stachybotrys* toxins indoors and neurological damage.<sup>2,26,49</sup> Although severe health effects from the inhalation exposures to

*Stachybotrys* toxins indoors is plausible, it is not well-supported, and the issue remains controversial.<sup>2,3,5,27,49,50</sup>

Organic dust toxic syndrome (ODTS) describes the abrupt onset of fever, flu-like symptoms, and respiratory symptoms in the hours following a single, heavy exposure to dust-containing fungi and other microorganisms. Unlike HP, ODTS does not require repeated exposures to bioaerosols and can occur after the first exposure. ODTS has been documented in farm workers handling contaminated material, but may also affect workers performing remediation of building materials with widespread mold growth.<sup>2,11,27</sup> ODTS is a self-limited illness, which usually improves within 24 hours after the discontinuation of exposure. It may be underreported among workers exposed to fungi, but would not be expected in occupants of buildings with mold growth.<sup>11,27</sup>

## Infectious Disease

Only a small number of fungi have been associated with infectious disease. Few of these fungi are typically found in the indoor environment.<sup>51,52</sup> Several species of *Aspergillus* are known to cause aspergillosis, most commonly *A. fumigatus*, *A. flavus*, and rarely, other species. Aspergillosis is a disease that generally affects severely immunosuppressed persons. Exposure to these molds, even in high concentrations, is unlikely to cause infection in healthy individuals.<sup>21,53</sup> Heavy exposure to fungi associated with bird and bat droppings (*e.g.* *Histoplasma capsulatum* and *Cryptococcus neoformans*) can lead to health effects, usually transient flu-like illnesses, in healthy individuals. More severe health effects are primarily encountered in immune-compromised persons.<sup>18,54</sup>

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## **Preventing and Cleaning Mold Growth**

### **Fact Sheet for Building Owners and Managers**

Mold (mildew) is a fungus that can grow inside building on wet or damp surfaces. Mold can cause allergic

reactions, trigger asthma attacks, or cause other health problems in some people.

Mold needs water or moisture to grow. Stop indoor mold growth by fixing leaks, drying damp or wet areas and controlling humidity. Before a clean-up, refer to the complete “Mold Guidelines” at [nyc.gov/health](http://nyc.gov/health).

#### **PREVENT MOLD GROWTH**

##### **Fix Water Problems Immediately**

- Correct water leaks.
- Dry any and all water-damaged items or areas.

##### **Control Moisture Sources**

- In bathrooms without windows, check that bathroom fans or exhaust vents are working.
- In bathrooms with windows, check that the window can be opened.
- Use a dehumidifier to lower humidity levels in basements.

#### **CHECK THE SIZE OF THE AREA WITH MOLD GROWTH AND WATER DAMAGE**

- Look for hidden mold and water damage
- If the amount of mold observed covers a large area (more than 100 square feet), is in the HVAC system, or is difficult to get to, you may need professional help.
- If there is less than 100 square feet of mold growth, trained building staff should be able to do the cleanup job.

#### **FOLLOW THE PROPER STEPS TO CLEAN MOLD GROWTH**

- Tell people living or working in the building about the plan to clean the mold growth.
- Tenants and others should leave the work area before cleaning begins.

- Cover or remove difficult-to-clean surfaces or items (e.g. carpeting, electronics) from the work area before cleaning begins.
- Use safety goggles, gloves, and a disposable respirator when removing mold growth.
- Clean mold growth with soap or a detergent, and water.
- Remove and throw away porous materials (e.g. ceiling tiles, insulation) with mold growth on them.
- Dispose of any plastic sheeting, moldy materials, and used sponges or rags in sealed heavyduty plastic bags.
- Always fix water problems immediately. If the mold returns quickly or spreads, you may have an ongoing water problem.

**If more than 10 square feet of mold growth is present also:**

- Cover the floor in the work area with plastic sheeting.
- Cover entry and exit pathways with plastic sheeting.
- Seal any ventilation ducts with plastic sheeting.
- Mop and/or HEPA-vacuum the work area and pathways.

**CLEAN MOLD GROWTH WITH PROPER SUPPLIES**

- Soap or detergent
- Disposable rags/sponges and scrub brush
- Buckets
- Heavy-duty plastic garbage bags
- Protective gear (e.g. goggles, rubber gloves, N95 respirator)

**FOR MORE INFORMATION**

Visit our web site at [nyc.gov/health](http://nyc.gov/health) for the complete “Mold Guidelines” or **call 311**.