Facts about Mold

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Introduction

For over a decade, mold has remained in the news. People are talking about the effect on population health and damage to the building. But what are the risks and issues?

The available science on molds and their potential health effects remains under study, but considerable progress has been made. The US Centers for Disease Control and Prevention (CDC), the Institute of Medicine of the US National Academy of Sciences, the World Health Organization, and Health Canada all agree that living or working in a building with mold damage results in increased risk of respiratory disease. Although there are several guidance documents available, there are no accepted national or international standards for mold investigation, evaluation or remediation. The American Industrial Hygiene Association (AIHA), however, has worked to translate the advice from the previously mentioned government agencies into state-of-the-art inspection and sampling protocols, such as AIHA's *Recognition, Evaluation and Control of Indoor Mold* book, also known as the Green Book. If properly used, these methods are suitable for assessing hidden contamination and directing essential visual inspections. For health outcomes, there are no available exposure assessment methods that can provide useful information for individuals. This is primarily due to the fact that each person's response to mold exposure is unique.

The scientific complexities surrounding this issue would be a huge challenge, but the truth is that other, less scientific, difficulties dwarf them. Media attention on this topic often creates emotionally charged circumstances, making scientific and professional judgment, as well as reasoned dialogue on this subject, very difficult. In some instances, building owners have been known to ignore or dismiss potentially serious problems. Importantly, many indoor air quality (IAQ) problems have nothing to do with mold, and buildings seldom have only one indoor environmental quality problem. It is essential to consider multiple sources of building IAQ problems instead of focusing on just mold concerns. In other instances, building occupants or public officials armed with mold sampling reports of dubious quality have reacted with alarm to potential threats, making risk communication very difficult.

This fact sheet represents a consensus statement by a group of experts about important aspects of the "state of the science." The guidance offered is practical information based on years of experience addressing mold issues, and this document does not claim to be a definitive or comprehensive position statement. Because it is not comprehensive, it should always be used in conjunction with other existing guidance documents, as well as professional judgment by qualified consultants and public health officials.

It should be noted that public and occupational health practice is rarely an exact science. Prevention always poses the challenge of making tough and often costly decisions with incomplete information or understanding. For a more complete analysis of the situation, see AIHA's *Recognition, Evaluation and Control of Indoor Mold*, available from www.aiha.org or by calling (703)-849-8888.

The Facts about Mold: For Everyone

What is mold? The term "mold" is a colloquial term for a group of filamentous fungi that are common on food or wet materials. This includes the green *Penicillium* species that produces penicillin, and fungi that spoil our bread, fruit, cheese and crops. Most of these are Ascomycetes that produce a lot of spores. The majority of the molds that grow on damp building materials are found in the soil and are adapted to grow on a wide variety of materials. Outdoors, molds live in the soil, on plants, and on dead or decaying matter. There are thousands of species of mold and they can be any color. Different mold species are adapted to different moisture conditions ranging from very wet to just damp. Many times, mold can be detected by a musty odor. Live spores act like seeds, forming new mold growths (colonies) under the right conditions. All of us are exposed to a variety of fungal spores daily in the air we breathe, both outdoors and indoors.

How does mold get into a house or building? Mold and fungal spores occur naturally outdoors, where fungi are the earth's most important recyclers. Indoors, mold needs moisture to grow; it becomes a problem only where there is water damage, elevated and prolonged humidity, or dampness. Common sources of excessive indoor moisture that can lead to mold problems include:

- flooding from surface waters (i.e., overflowing rivers) or from severe storms;
- roof leaks from damaged or missing roofing materials, ice dams or blocked gutters;

- storm-driven rain through window frames, exterior walls or door assemblies;
- leaking pipes, sewer back-ups or overflows;
- damp basements or crawl spaces due to a high water table (rising damp) or poorly managed rainwater drainage; and
- condensation on cold surfaces.

How can I prevent mold growth? The key to preventing and stopping indoor mold growth is to control excessive moisture and condensation. Keeping susceptible areas in the home clean and dry is critical. In general, mold will not grow indoors without water, dampness or excessive moisture.

There are three main factors that contribute to condensation of water on building surfaces:

- Relative Humidity: Condensation occurs when the air is saturated with water and it cannot hold any more moisture. For example, steam generated from bathroom showers or from cooking can fill up the air with moisture, which will then condense into drops of water on cooler surfaces, such as mirrors and windows. Where possible, localized sources of humidity, such as clothes dryers, should be directly vented to the outdoors. To lower indoor humidity during warm, humid weather, air conditioners and/or dehumidifiers should be used. In chronically damp areas, such as basements or crawlspaces, it is often recommended that dehumidifiers be used to maintain humidity levels below 60%.

- Temperature: Warm air holds more moisture than cold air. Condensation occurs when warm humid air comes into contact with a cold surface and the moisture condenses into water. This can often be seen on single-pane windows, where water condenses and then runs down, causing the wood frames and sills to rot and the wall under the windows to blister. Condensation can occur on exterior walls, particularly north-facing walls, if they are not properly insulated. Other chronically cold surfaces, such as cold water pipes, should be covered with insulation to help prevent condensation.

- Poor Ventilation: Indoor humidity can build up if there is not enough ventilation and exchange of indoor and outdoor air. Where there is little or no air movement, such as behind dressers and cabinets, surfaces can remain cooler than surrounding areas, which can lead to increased condensation and mold growth. It is recommended that the area be ventilated and the occupants use exhaust fans (vented to the outdoors) to remove moisture from high humidity areas, particularly in bathrooms, kitchens, and laundry areas. Furniture should be moved slightly away from walls so that air can freely pass behind them. Air should be allowed to circulate between rooms and regularly ventilate to remove humid air. Fans should be used as needed.

Other things that can be done are to clean and repair gutters regularly, make sure the ground slopes down and away from the home’s foundation, and keep air conditioner drip pans and drain lines clean. In addition, in air conditioned buildings in hot and humid climates, vinyl wall coverings on the interior sides of exterior walls should not be used as these materials can trap moisture, resulting in mold growth underneath them.

In the case of floods or leaking pipes, any standing water should be promptly removed and water damaged materials should either be dried out and cleaned, or removed and replaced. Porous materials that are wet for more than 48 hours are likely to produce mold growth and should be discarded. In instances where the water damage is extensive, it is recommended that professional help, such as a commercial restoration company, be consulted.

Can mold spores contain toxins? Yes. Some of these fungi produce toxic metabolites (mycotoxins), and almost all molds that grow in the built environment can produce triple helical glucan, both of which are toxic to lung cells. Many studies in appropriate laboratory animals have demonstrated that very low exposures of these compounds can result in inflammation. The health effects of breathing mycotoxins indoors are not well understood and they continue to be under study. This research is done to better understand why epidemiological studies consistently show increased asthma among occupants of damp buildings not associated with atopy.

Some studies have shown that in agricultural settings, occupational exposure to fungi that produce mycotoxins on grain may result in significant exposures to their toxins. However, it is important to not relate human exposures to mycotoxins in agricultural settings with those exposures that can occur in the built environment (homes and offices). Exposures to mycotoxins in agricultural environments can be at much higher airborne concentrations, and these levels can result in systemic exposure. It should be noted that these agricultural exposures tend to be fungi that do not generally occur in buildings, such as *Aspergillus flavus* (aflatoxin) and *Fusarium graminearum* (deoxynivalenol).

What is "black mold"? The news media and some contractors often refer to "black mold" or "toxic black mold." It is usually associated with *Stachybotrys chartarum*, a type of greenish-black mold commonly associated with heavy water damage. Not all molds that appear to be black are *Stachybotrys.* The known health effects from exposure to *Stachybotrys* are similar to those caused by other common molds, and again in high exposure situations (as in agriculture), are known to be associated with severe health effects in some people. Such exposures seldom, if ever, occur in buildings except during remediation activities by people not taking appropriate precautions.

Should I be concerned about mold? It all depends on how much. Small amounts of mold growth in workplaces or homes (such as mildew on a shower curtain) are not a major health concern. Large quantities of mold growth, however, are an important public health concern. In addition, mold can damage building materials, finishes, and furnishings and, in some cases, cause structural damage to wood.

How do molds affect people? Most people have no reaction when exposed to molds. Allergic reactions, similar to pollen or animal allergies, and irritation are the most common health effects for individuals sensitive to molds. Flu-like symptoms and skin rash may occur. Exposure to molds may also aggravate asthma. In very rare cases, fungal infections from building-associated molds may occur in people with serious immune disease. Most symptoms are temporary and eliminated by correcting the mold problem.

Who is affected by exposure to mold? There is a wide variability in how people are affected by airborne mold spore exposure. Currently, there is no established airborne concentration that is known to adversely affect any individual's health. People who may be affected more severely and quickly than others include:

- Infants and children
- Elderly people
- Pregnant women
- Individuals with respiratory conditions or allergies and asthma
- Persons with weakened immune systems

Those with special health concerns should consult their doctor if they are concerned about mold exposure. Symptoms that may seem to occur from mold exposure may be due to other causes, such as bacterial or viral infections or other allergies.

What should I do if I see or smell mold in my home? The most important step is to identify the source(s) of moisture, which result in mold growth, and to take the necessary steps to make repairs to stop them. If you only clean up the mold, and do not fix the moisture problem, then most likely the mold growth will recur. If the source of the moisture is related to a building failure or fault, such as a burst pipe or leaking roof, it is recommended that a professional contractor be consulted. In instances where the moisture source does not appear to be related to leaks, floods, structural faults or rising damp, it is most likely due to condensation (see "How can I prevent mold growth?"). If you do not see mold growth but smell a musty odor, mold may be growing underneath or behind water-damaged materials, such as walls, carpeting, or wallpaper.

Once the source of the moisture has been identified and fixed, you need to decide if removing the mold from the affected areas is something that can be done without professional assistance. If the mold growth was caused by sewage back-up or other contaminated water, potential pathogens may be present and the work should be performed by a professional contractor that has experience in cleaning buildings damaged by contaminated water.

If the mold growth is due to condensation or small-scale leak and is limited to a small area (less than 10 square feet), you can probably do the work yourself following guidelines such as those that have been prepared by the U.S. Environmental Protection Agency (EPA), Canada Mortgage and Housing Corporation and AIHA. On hard surfaces, such as countertops and furniture, use detergent and water to wash mold off and then dry completely. The use of biocides or chemical disinfectants is not recommended as these may be hazardous to occupants. Moldy porous or absorbent materials, such as ceiling tiles, wallboard, and carpeting, should be removed and replaced. Persons cleaning mold should wear rubber gloves, goggles and an approved respirator to protect against breathing airborne spores (an N95 respirator would be appropriate for most cleanup projects, provided that you are medically capable of wearing a respirator). If you have health concerns, you should consult your doctor before doing any mold cleanup.

Over the past decade or so, the industry has given rise to many individuals and companies who tout themselves as experts and certified in various aspects of mold investigation and remediation, but who may have little or no practical experience. If you choose to hire a consultant to help identify your problem, or a contractor to perform the cleanup in your home, make sure that they have specific work experience in dealing with and cleaning up mold, and check their references.

Should I test my home for mold on a routine basis? Probably not. Looking for evidence of water damage and visible mold growth should be your first step. Testing for mold is expensive, and you should have a clear reason for doing so. In addition, there are no standards for “acceptable” levels of mold in the indoor environment. When air testing is done, it is usually to compare the levels and types of mold spores found inside the home with those found outdoors. If you know you have a mold problem, it is more important to spend time and resources solving the moisture problem and getting rid of the mold than to spend it on sampling.

Who do I call to deal with extensive mold growth in a building? A professional experienced in mold evaluation and remediation, such as an industrial hygienist, may need to be hired to address extensive mold growth in a building. It is important to correct large mold problems as soon as possible by first fixing the source of the moisture problem and removing contaminated materials, then cleaning the surfaces, and finally drying the area completely. If you use outside contractors or professionals, make sure they have experience cleaning up mold. Check their references, and have them follow the recommendations and guidelines given in the information resources at the end of this fact sheet.

The Facts about Mold: For the Professional

How should a building be evaluated for mold growth? The first step is to perform an inspection to check building materials and spaces for visible mold growth, signs of moisture damage indicating a history of water leaks, elevated humidity levels, and/or condensation. Any occupant complaints should be noted, as well as any musty or moldy odors.

Components of the building’s ventilation system should be inspected, with particular emphasis on the filters, cooling coils (if present), the fan chamber and any internal insulation. If mold growth or moisture problems are found, the air pressure differentials between the area of growth and surrounding areas should be determined. The location of the mold and moisture damage should also be characterized to determine its impact on the building and its occupants. The risk of potential health consequences varies depending upon the amount of visible mold/moisture damage and the degree of isolation from the occupied space. Exposure risk from greatest to least would be 1) growth on surfaces exposed to occupied space, 2) on interior walls or floor cavities and 3) in exterior walls with poor air barriers. If the mold damage is in the ventilation system, immediate steps are required to stop the spread of contamination. If the contamination is on the surface of walls, ceilings or floors exposed to the occupied space, prompt steps are required to contain the mold-damaged areas because what is visible is just a fraction of the total.

When is sampling necessary in a building evaluation? Air, surface or bulk sampling may not be necessary, depending on the goal of the investigation. If visible mold is present, then it should be remediated, regardless of what species are present or whether or not samples have been collected. In situations where visible mold is present and there is a need to have the mold identified, surface or bulk sampling may be warranted. In specific instances, such as cases where health concerns are an issue, litigation is involved, or the source(s) of contamination is unclear, sampling may be considered as part of a building evaluation.

If mold is suspected but not visibly detectable after a thorough inspection, then microbial air sampling conducted in accordance with guidance documents (such as AIHA’s second edition of *Field Guide for the Determination of Biological Contaminants in Environmental Samples*—also known as the Field Guide—and AIHA’s Green Book) may reveal evidence of mold amplification or reservoirs indoors, particularly of mold that is considered“hidden” behind walls and other building structures. If mold is being removed and there is a question about how far the colonization extends, then surface or bulk sampling, in combination with moisture readings, may be useful. Sampling for airborne mold spores can indicate whether the mix of indoor molds is “typical” of the outdoor mix or, conversely, “atypical” or unusual at the time of sampling.

Any sampling that does occur must be performed by professionals such as an industrial hygienist experienced with mold issues and familiar with current guidelines and, if applicable, local regulations. If samples are collected, regardless of the purpose, the results should help answer a clear question. Sampling without a specific purpose greatly increases the chances of generating useless data. Note that laboratories vary in experience and proficiency; using an AIHA-LAP, LLC EMLAP-accredited lab or equivalent is recommended.

Why are there no standards for mold exposure? Health hazards from exposure to environmental molds and their metabolites relate to four broad categories of chemical/biological attributes. These materials may be: 1) irritants, 2) allergens, 3) toxins, and rarely 4) pathogens. Different mold species may be more or less hazardous with respect to any or all of these categories. In addition, individual risks from exposure to a particular mold species may vary depending on a number of factors.

Uncertainty is further complicated by a lack of information on specific human responses to well-defined mold contaminant exposures. In combination, these knowledge gaps make it impossible to set simple, meaningful exposure standards for molds and related contaminants.

With no standards, how do I interpret my sampling results? A useful method for interpreting microbiological results is to compare the kinds and levels of organisms detected in different environments. Usual comparisons include indoors versus outdoors, or complaint areas versus non-complaint areas. Specifically, in buildings without mold problems, the qualitative diversity (types) of airborne fungi indoors and outdoors should be similar. Conversely, the dominating presence of one or two kinds of fungi indoors, coupled with the absence of the same kind of fungi outdoors, may indicate a moisture problem and degraded air quality.

Also, the consistent presence of certain fungi, such as *Stachybotrys chartarum*, *Aspergillus versicolor*, or various *Penicillium* species, over and beyond background concentrations may indicate the occurrence of a moisture problem and a potential atypical exposure. Generally, indoor mold types should be similar to, and airborne concentrations should be no greater than, those found outdoors and in non-complaint areas. Analytical results from bulk material or dust samples may also be compared to results of similar samples collected from reasonable comparison areas.

Comparisons of total bacterial levels indoors versus outdoors may not be as useful as with fungi, since natural bacteria reservoirs exist in both places. Comparisons of the specific types of bacteria present, excluding those of known human origin, can help determine building-related sources.

Does mold remediation always require isolation/containment? Mold remediation should always require some level of isolation of materials or containment. The lower level of containment or isolation involves sealing removed moldy materials in a plastic bag for disposal. Local-area or full-area containment decisions should be made based on the size of the area of mold growth and moisture damage, along with the potential for occupant exposure or building contamination without containment. These decisions should be based on an understanding of the full scope of mold contamination, including both visible and possible hidden mold sources.

Are biocides useful or required in remediation projects? Biocides are disinfectant chemicals used to kill germs. In most mold remediation projects, biocides are not a substitute for thorough cleaning. Biocides are of limited use in remediation of indoor mold contamination for two main reasons:

1) Because applications of biocides are variable, these treatments do not always remove allergens that can lead to allergies in sensitive individuals, nor do they remove other metabolites from mold that can cause adverse reactions in some people. Even though the application of biocides may kill mold spores, the only way to remove the allergens and other metabolites is through the physical elimination of mold and moldy materials by thorough cleaning or removal.

2) Commonly used biocides do not effectively kill molds. For example, active fungal growth on a surface may produce a spore density of 1 million spores per square inch. Treating this site with a biocide that has an effectiveness of 99.999% would still leave an estimated 10 viable spores per square inch. As such, mold growth may recur if the underlying moisture problem is not resolved.

Biocidal treatments are indicated only when the contaminant is one of the few fungi, such as *Aspergillus fumigatus,* that are known to cause human infection. This is particularly important in health-care facilities or other places with occupants who have impaired immune systems or who may be more susceptible to infections.

If a contractor proposes the use of biocides, insist that you see information from the US EPA or Health Canada that it is approved for use indoors to remediate mold in the USA or Canada, respectively.

What are the knowledge gaps concerning mold exposure and its health effects? Chief among the knowledge gaps are: (1) defining how mycotoxins affect human health and (2) the health risks associated with mycotoxins, microbial volatile organic compounds, allergen, and glucan exposures.

The causes of individuals' susceptibility to infectious fungi are relatively well understood. Conversely, the mechanisms responsible for allergic sensitization, contact dermatitis, hypersensitivity pneumonitis, and inhalation fevers vary from incompletely characterized to entirely unknown. Predisposing host factors influence individual susceptibility to environmental exposures.

The lack of meaningful exposure limits for most indoor air quality contaminants is a major obstacle to establishing regulatory standards for individual exposure to airborne contaminants. The same is certainly true for molds. Until microbiological methods for demonstrating mold concentrations in the environment are standardized and reproducible, epidemiological studies necessary to determine dose-response can only suggest association, not cause and effect, with respect to mold exposures and health effects.

Resources

Listings of indoor air quality consultants can be obtained from AIHA's *Consultants Listing*, although AIHA does not recommend specific consultants. Additional technical information is included in the following sources:

- Recognition, Evaluation and Control of Indoor Mold, AIHA, 2008 (the Green Book)
- Field Guide for the Determination of Biological Contaminants in Environmental Samples, 2nd edition, AIHA, 2005 (the Field Guide)
- Assessment, Remediation, and Post-Remediation Verification of Mold in Buildings, AIHA, 2004
- Environmental Mold: State of the Science, State of the Art, AIHA, 2003
- Report of Microbial Growth Task Force, AIHA, 2001
- Listing of AIHA Laboratory Accreditation Programs, LLC Environmental Microbiology Laboratory Accreditation Program (EMLAP) accredited laboratories
- IICRC S500, Standard and Reference Guide for Professional Water Damage Restoration, Institute of Inspection, Cleaning, and Restoration Certification, www.iicrc.org 2006
- Mould Guidelines for the Canadian Construction Industry. CCA 82-2004, CCA, 2004
- Mold Remediation in Schools and Commercial Buildings (EPA 402-K-01-001), Environmental Protection Agency (EPA), www.epa.gov/iaq/molds/index.html 2001
- Bioaerosol: Assessment and Control, ACGIH, 1999

For More Information

- State or Local Department of Health
- Environmental Protection Agency (EPA): www.epa.gov/iaq
- EPA and FEMA (Federal Emergency Management Agency) Flood Clean-Up Guidelines: www.epa.gov/mold/moldresources.html#Floods/Flooding and www.fema.gov/hazard/flood/index.shtm
- Centers for Disease Control and Prevention (CDC): www.cdc.gov/mold/default.htm
- California Indoor Air Quality Program: http://www.cal-iaq.org/mold/about-mold
- New York City Department of Health "Guidelines on Assessment and Remediation of Fungi in Indoor Environments": www.nyc.gov/html/doh/html/epi/moldrpt1.shtml
- Canada Mortgage and Housing Corporation: http://www.cmhc-schl.gc.ca/en/co/maho/yohoyohe/momo/

The Facts about Mold: A Glossary

Allergen: A substance that elicits an antibody response and is responsible for producing allergic reactions by inducing formation of IgE. IgE is one of a group of immune system mediators. IgE antibodies, when bound to basophiles in circulation or mast cells in tissue, cause these cells to release chemicals when they come into contact with an allergen. These chemicals can cause injury to surrounding tissue—the visible signs of an allergy. Fungal allergens are proteins found in either the mycelium or spores. Only a few fungal allergens have been characterized, but all fungi are thought to be potentially allergenic.

Atopy: This term refers to the genetic tendency to develop allergic diseases such as allergic rhinitis, asthma and atopic dermatitis (eczema). Atopy is typically associated with heightened immune responses to common allergens, especially inhaled allergens and food allergens.

Biocide/Fungicide: Chemicals that limit the growth of or kill microorganisms such as fungi.

"Black mold": This poorly defined term, which has no scientific meaning (also called "toxic black mold"), has been associated with *Stachybotrys chartarum*. While only a few molds are truly black, many appear black. Not all molds that appear to be black are *Stachybotrys*.

Fungi: Neither animals nor plants, fungi are classified in their own kingdom. The fungi kingdom includes a very large group of organisms, including molds, yeasts, mushrooms, and puffballs. There are more than 100,000 accepted fungal species—but current estimates range up to 10 million species. Mycologists (people who study fungi) group fungi into four large groups according to their reproduction method.

Glucan: Glucans are polysaccharides comprised primarily of glucose present in plants and fungi. In buildings, both plant and fungal glucan are present. Different chemical forms of glucan have different effects on health. Some glucans are marketed as being good for health such as the glucans that come from mushrooms. The form of glucan that dominates in molds such as *Aspergillus* and *Penicillium* and related fungi is called beta-1, 3- D-glucan in triple helical form. Triple helical glucan reacts to the glucan receptor in the lung, and this results in inflammatory processes being stimulated.

Hidden mold: Visible mold growth on building structures that is not easily seen—for example, above drop ceilings, within wall cavities (the space between the inner and outer structure of a wall), inside air handlers, or within the ducting of a ventilation system. Visible mold within a ventilation duct is in immediate contact with the occupied space. Spores released from such growths are affected by air movement and relative humidity. Spores of mold growth in wall cavities are released by the air exchange between the wall cavity and occupied space. The rate of spore movement between such spaces is typically slow. Volatile gases produced by visible mold growth in wall cavities are also known to occur and migrate to occupied spaces even through air barriers.

Microbial volatile organic compounds (MVOCs): Chemicals produced by fungi as a result of their metabolism. Some of these chemicals are responsible for the characteristic moldy, musty, or earthy smell of fungi, whether mushrooms or molds. Some MVOCs are considered irritants, and their presence is usually annoying. Specific MVOCs are thought to be characteristic of wood rot and mold growth on building materials. The human nose is very sensitive to mold odors, sometimes more so than current analytical instruments.

Mold: A group of organisms that belong to the fungi kingdom (see Fungi). Although the terms mold and fungi have been commonly referred to interchangeably, all molds are fungi, but not all fungi are molds.

Mycotoxins: Compounds produced by "toxigenic fungi" that are toxic to humans or animals. By convention, the term "mycotoxins" excludes mushroom toxins and compounds of low potency or toxicity only in in-vitro systems. The ordinary use of the term refers to compounds of importance in agriculture. This includes a small number of very potent compounds such as deoxynivalenol, aflatoxin, fumonisin, ochratoxin, and zearalenone. It also includes the much less common nivalenol, T-2/HT-2 toxins, as well as some other *Penicillium* and *Aspergillus* toxins and toxins from *Stachybotrys chartarum* and *Pithomyces chartarum*. The biochemical targets of mycotoxins are usually many, but the mechanisms of toxicity, even within families of toxins, are typically different. It is important to remember that the toxins from agriculturally important fungi, including deoxynivalenol, aflatoxin, fumonisin, ochratoxin, T-2 toxin and zearalenone, do not occur on building materials.

The genetic property to produce mycotoxins is particular to given species. Some species including *Fusarium graminearum* and *S. chartarum* have genetic subpopulations called chemotypes that produce different mixtures of compounds. In the case of *F. graminearum*, these chemotypes are distributed by continent. In the case of *S. chartarum*, both chemotypes occur together.

Remediate: To fix a problem. Related to mold contamination, remediation includes fixing the water/moisture problem and the cleaning, removal, and/or replacement of damaged or contaminated materials.

Spore: General term for a reproductive structure in fungi, bacteria, and some plants. In fungi, the spore is the structure that may be used for dissemination and may be resistant to adverse environmental conditions.

***Stachybotrys*:** Genus that includes approximately 10 species and occurs mainly on dead plant materials. Of these, *Stachybotrys chartarum* and its sister species *S. chlorohalonata* are the most common. These species are widespread and typically grow on straw. In the indoor environment, *Stachybotrys* is commonly found on cellulosic materials, including paper, canvas, and jute, that are wetted to a water activity > 0.98. This is a toxigenic mold. There are two chemotypes of this species that produce trichothecenes plus spirolactones or atranones plus spirolactones; these toxins have been demonstrated on mold-damaged building materials. The closely related species *Memnoniella echinata* occurs on the same materials but does not produce potent trichothecenes. Both chemotypes of *S. chartarum*/*S. chorohalonata* and *M. echinata* typically occur together on samples of very wet cellulosic materials with *M. echinata* being more important in warmer climates. This fungus does not cause invasive disease. Allergens of *S. chartarum sensu latto* have been identified.

"Toxic mold": This has no scientific meaning, since mold itself is not toxic. The metabolic byproducts of some molds may be toxic (see Mycotoxins).

Toxigenic fungi: Fungi that can produce mycotoxins (see Mycotoxins).

Common Indoor Fungi

***Alternaria*:** A genus comprised of approximately 50 species, most of which are saprophytes or plant pathogens. *Alternaria alternata* is an extremely common saprophyte found worldwide on plants, wood, wood pulp, textiles, and food. *A. alternata* grows on the surfaces of leaves (phylloplane) and occurs in outdoor air at modest levels, peaking in July or August depending on the location (reaching perhaps 500 spores/m^3). The allergens of *A. alternata* can induce reactions at very low concentrations in sensitized individuals. Phylloplane strains of *A. alternata* that are found in air do not produce AAL toxin. Some produce the phytotoxin (a compound toxic to plants) alternariol and related metabolites.

***Aspergillus*:** The asexual stage of a number of Ascomycetes. Species of *Aspergillus* are distributed worldwide, although they are more common in warmer climates. These species grow on a vast array of organic materials. There are 182 accepted species, although only 40 occur with any frequency. Species of *Aspergillus* include several of considerable economic importance: *A. flavus* is the main producer of the potent carcinogen aflatoxin and *A. fumigatus* is an important cause of the invasive disease aspergillosis. Several species are common on building materials, including *A. versicolor*. *A. fumigatus* is common in outdoor air in some regions during the fall, occurring on composting materials.

***Cladosporium*:** A genus comprised of approximately 500 species, most of which are saprophytes or plant pathogens; perhaps 20 are common. *Cladosporium sphaerospermum*, *C. cladosporoioides*, and *C. herbarum* are the most common species. All are found on plants, wood, wood pulp, textiles, and food. Of the three, *C. sphaerospermum* is the species typically found on building materials. The other two are phylloplane species that occur in outdoor air at high levels, peaking in June, July, or August depending on the location (reaching perhaps 10,000 spores/m^3). *C. herbarum* produces a wide variety of allergens, and approximately 10 percent of the population is sensitized to *Cladosporium*. Phylloplane strains of *Cladosporium* do not produce metabolites with material toxicity.

***Penicillium*:** The asexual stage of a number of Ascomycetes. The species of *Penicillium* are found worldwide but are more common in temperate climates. These species grow on a vast array of organic materials. There are 225 accepted species, although only 70 occur with any frequency. Species of *Penicillium* include several of considerable economic importance: *P. verrucosum* produces ochratoxin on cereals and *P. chrysogenum* produces penicillin. Many *Penicillium* species cause damage in damp building materials, including the toxigenic species *P. aurantiogriseum*.

This fact sheet is a joint effort by the following AIHA technical committees:
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Indoor Environmental Quality (IEQ)