

# MOLD IN RESIDENTIAL BUILDINGS

## BACKGROUND

The presence of mold in residential and commercial buildings is generating a new wave of litigation against builders, building owners, and property managers for personal injury and property damage. It has been the subject of disputes between insurers and their policy holders. And, while mold growth in indoor environments is not new, the issue has generated national media attention and led to the creation of dozens of mold sites on the Internet. Visible mold growth in a home is never acceptable; however, the scientific and medical literature contains differing opinions regarding the potential health impacts of exposure to mold. Moreover, there is conflicting information about the proper methods for investigating and remediating mold, which has led to uncertainty and fear in the minds of many. This paper is intended to provide an overview of some of the mold issues and to alleviate undue concern about mold in indoor environments.

## CAUTION AND PERSPECTIVE

This document is not intended to be exhaustive and all-inclusive, but merely a primer on some issues and practices that homeowners and builders may consider about mold within residential buildings. As such a primer, this information is not intended to be a standard or minimum requirement, and the information expressed herein is a summary of publicly available documents from authoritative sources. Mold growth on building exteriors, within the structural system and building design are not addressed in this document.

Readers are cautioned about the potential health consequences from exposure to mold, and from clean-up and repair techniques. Medical, health science, and building science professionals have not formed consensus on these topics; however, this primer introduces the reader to the topics of concern and provides references to documents from authoritative sources. Most of the reference documents are readily available at no cost through the World Wide Web.

The reader should be aware that the reference documents contain conflicting and inconclusive information about health effects from exposure to mold, clean-up procedures, acceptable indoor air moisture levels and ventilation. However, two issues most experts agree upon are: active mold growth should be removed, and eliminating excessive moisture is required to stop mold growth. Armed with information from the reference documents, the reader should be able to make an informed decision about dealing with mold. A medical professional and/or local government health authority should be contacted for guidance when there is a concern about health and life safety.

Press coverage about lawsuits and health studies involving mold has focused on one type of mold called *Stachybotrys chartarum*, which has been named "the

toxic mold." There is no particular reason why this mold should be singled out. All molds should be treated with caution. This document provides information about *Stachybotrys chartarum*; not to draw attention to it, but only to answer questions about this current curiosity.

## **MOLD IN THE ENVIRONMENT**

Molds are a subset of the fungi family and are common, abundant, and an essential part of the world's ecological system. Fungi are found nearly everywhere and are necessary for recycling organic material, which is required to sustain plant and animal life.

Mold spores are airborne and travel into and out of buildings as air is exchanged and with the movement of people and their belongings. Mold grows on wet surfaces and, if left untreated, may eventually release spores into the air. Airborne mold spore concentrations can become unhealthful when large areas are wet for prolonged periods. Resolving excessive moisture conditions can prevent and minimize mold growth in the indoor environment.

## **MOLD GROWTH**

In order to reproduce, molds release tiny spores just as plants produce seeds. The spores settle on surfaces and, when conditions are favorable, they begin to consume organic material in their immediate vicinity. Molds can grow on cloth, carpet, leather, wood, wallboard, household dust, and on anything that is made of organic material. Sustained mold growth requires moisture, organic material (a food source), and a suitable temperature generally in the range of 40° to 100°F. When one or more of these three conditions are unsatisfactory, the mold colony will become dormant. When favorable conditions are restored, the dormant colony will resume its metabolic activity.

Molds can produce compounds that become airborne along with the mold spores. A toxic substance called mycotoxin can cling to the surfaces of spores; other substances may be found within spores. Molds also produce volatile bioaerosols that are released directly into the air. These compounds often have strong, unpleasant odors (a musty smell) that are commonly associated with molds.

## **HOW TO LIMIT MOLD GROWTH**

The most practical approach to limit mold growth is early detection and prompt resolution of excessive moisture. If you can see mold or detect an earthy or musty odor, you can assume you have a moisture problem that must be resolved to achieve a permanent solution to arresting mold growth. Mold growth is found behind walls or under materials where water has damaged surfaces. Look for discoloration and mold on surfaces.

Controlling indoor air moisture will limit the probability of supporting mold growth from condensing water on interior surfaces; such as on walls, windows, and areas near air conditioning supply registers. Relative humidity is a measure of the amount of water vapor in air. Relative humidity meters are useful for detecting excessive moisture and they are available from most hardware stores. Moisture sources that increase indoor air relative humidity are: habitation (people release moisture), bathing, cooking, plants, washing and air-drying of dishes and clothes, unvented combustion appliances, humidifiers, and outdoor ventilation air in humid climates.

Another moisture source is water from leaks; such as from pipes, rain water leakage through windows, roof flashing, ice dams, etc.

Listed below are strategies that can help minimize mold growth.

- Take notice of musty odors in the home because they indicate the presence of mold. Look for visible signs of mold and abate the moisture source.
- Watch for condensation and wet spots and eliminate sources of moisture.
- Prevent moisture resulting from condensation by increasing surface temperatures or reducing moisture levels in the air. To increase the surface temperature, insulate or increase the circulation of heated air. To reduce moisture levels in the air, repair leaks, increase ventilation (if outside air is cold and dry), or dehumidify.
- Perform building and HVAC inspections and maintenance. Repair the condensate drain if the air conditioning system's drip pan overflows with water.
- Vent clothes dryers to the outdoors.
- Run the air conditioner and/or a dehumidifier during the humid months of the year. Controlling indoor air moisture to below 65 percent relative humidity will limit the probability of supporting mold growth.
- Keep the relative humidity as low as is comfortable during the winter season for houses in cold climates. Mold growth on interior surfaces of exterior walls can occur during the heating season. The combination of cool surfaces and excessive humidity can cause a high near-surface relative humidity and condensation. Experience has shown that an air moisture level below 40 percent relative humidity during the heating season will prevent condensation on surfaces. This level of humidity may not be appropriate for houses in severe cold climates. A sign of excessive humidity is condensation on the inside of windows. If condensation is present for prolonged periods take steps to reduce the moisture source or increase ventilation.
- Clean and dry any wet or damp areas within 48 hours.
- Provide drainage for roof rainwater and maintain the ground with a slope that drains water away from the foundation.
- Repair water leaks in the building envelope as soon as possible.

- Do not store organic materials such as paper, books, clothes, etc., in humid locations (such as in unconditioned basements).
- Exercise extra care when cleaning up after water damage from flood and sewer water.
- Consider the use of dehumidifiers in areas such as unconditioned basements.

## **MOLD ABATEMENT AND REMEDIATION**

The New York City Department of Health publishes a guideline for professional mold assessment and remediation service providers. The guideline establishes five levels of abatement based on size of the affected area and discusses health protection measures for workers and occupants. See the Reference section at the end of this document for contact information to acquire a copy of the guidelines.

The California Department of Health Services also publishes clean-up procedures that are more oriented toward homeowners. See the Reference section for this contact information as well. The clean-up procedures established by this California agency recommend the use of a disinfectant (chlorine bleach) whereas the New York City guideline does not make a recommendation for use of a disinfectant.

The U.S. Environmental Protection Agency published the "Mold Remediation in Schools and Commercial Buildings" document that also provides guidelines and insight on clean-up procedures.

Common suggestions among the various documents include:

- Correct the source of excessive moisture.
- When handling or cleaning moldy materials, consider using a mask or respirator for protection against inhaling airborne spores. Respirators can be purchased from hardware stores; select one for particle removal (sometimes referred to as a N95 or TC-21C particulate respirator).
- Wear protective gloves, eye protection glasses, and clothing should be immediately washed.
- Take care to remove or clean contaminated materials in a way that prevents the emission of fungi and dust contaminated with fungi from leaving a work area and entering an occupied area.
- Non-porous (e.g., metals, glass, and hard plastics) and semi-porous (e.g., wood, and concrete) materials that are structurally sound and are visibly moldy can be cleaned and reused.
- Cleaning should be done using a detergent solution.

- Porous materials (e.g., ceiling tiles and insulation, and wallboard) with more than a small area of contamination should be removed and discarded. Porous materials that can be cleaned, can be reused, but should be discarded if possible.
- A professional restoration consultant should be contacted when restoring porous materials with more than a small area of fungal contamination.
- All materials to be reused should be dry and visibly free from mold.
- Periodic inspections should be conducted to confirm the effectiveness of remediation work.

## **TESTING FOR MOLD**

State health agencies and experts do not recommend testing to determine if you have a mold problem. Mold sampling can be expensive and requires special equipment and trained technicians to acquire reliable samples and test results.

Another issue is that there are few available standards for judging what is an acceptable concentration of mold. If sampling is carried out, an outdoor air sample needs to be taken at the same time as the indoor sample. This baseline provides a measure to determine if the indoor air mold spore count is greater than the outdoor concentration.

If you decide in favor of testing, consider engaging the services of a qualified laboratory and technician. Check with your local health department for recommendations on selecting a testing service. Also, the American Board of Industrial Hygiene operates a certified associate industrial hygienist program that requires its certified members:

- to have at least a bachelor's degree from an acceptable college or university with a minimum of 30 semester hours of science, as well as specific industrial hygiene coursework;
- to have completed a minimum of four years of professional level-1 industrial hygiene experience;
- to demonstrate that industrial hygiene responsibilities constitute more than 25 percent of the candidate's time and that the candidate is supported by professional references (one must be a certified industrial hygienist or associate credential holder); and
- to pass a comprehensive one-day examination.

## **EXPOSURE STANDARDS**

There is no health-based standard for exposure to mold.

## **POSSIBLE HEALTH EFFECTS OF MOLD EXPOSURE**

Health effects associated with mold fall into four groups as follows:

- No effect: Physiological mechanisms in healthy people may allow exposure to mold at low and high levels.
- Allergic sensitization and immune responses: These can include allergic rhinitis (hay fever), asthma, hypersensitivity pneumonitis (inflammation of lung tissue), and allergic skin diseases.
- Infectious growth of the mold in or on the body: People with compromised immune systems may be more vulnerable to infections by molds. Healthy individuals are usually not vulnerable to infections from airborne mold exposure.
- Disruption of cellular function: This level occurs with toxigenic effects by toxic compounds produced by certain molds.

## QUESTIONS AND ANSWERS ABOUT MOLD

*Source: U.S. Centers for Disease Control and Prevention*

In 1994, the U.S. Centers for Disease Control reported the deaths of several infants in Cleveland in a case that involved a type of mold called *Stachybotrys chartarum*. The alleged cause of the deaths was idiopathic pulmonary hemorrhage (IPH). Though the deaths were associated with exposure to *Stachybotrys chartarum*, a summary of peer reviews concluded that the association between IPH and exposure to *Stachybotrys chartarum* was not proven.

### **Q1: How do molds get in the indoor environment and how do they grow?**

**A:** Molds grow naturally in the indoor environment. Mold spores may also enter your house through open doorways and windows through heating, ventilation, and air conditioning systems. Spores in the outside air also attach themselves to people and animals, making clothing, shoes, bags, and pets convenient vehicles for transporting mold indoors. When mold spores drop on places with excessive moisture, such as where leakage may have occurred in roofs, pipes, walls, or plant pots or where flooding may have occurred, molds will grow. Many building materials provide suitable nutrients that encourage mold to grow. Wet cellulose materials, including paper and paper products, cardboard, ceiling tiles, wood, and wood products, are particularly conducive for the growth of some molds. Other materials such as dust, paints, wallpaper, wallboard, carpet, fabric, and upholstery commonly support mold growth.

### **Q2: How do you know if you have a mold problem?**

**A:** Large mold infestations can usually be seen or smelled.

**Q3: I heard about toxic molds that grow in homes and other buildings. Should I be concerned about a serious health risk to my family and me?**

**A:** The hazards presented by molds that may contain mycotoxin should be considered the same for other common molds that can grow in your house. There is always a little mold everywhere-in the air and on many surfaces. There are very few case reports that toxic molds (those containing certain mycotoxin) inside homes can cause unique or rare health conditions such as pulmonary hemorrhage or memory loss. A causal link between the presence of the toxic mold and these conditions has not been proven. A common-sense approach should be used for any mold contamination inside buildings and homes. The common health concerns associated with molds include hay fever like allergic symptoms. Certain individuals with chronic respiratory disease (chronic obstructive pulmonary disorder, asthma) may experience difficulty breathing. Individuals with immune suppression may be at increased risk for infection from molds. If you or your family members have these conditions, you should consult a qualified medical clinician for diagnosis and treatment. For the most part, routine measures will prevent mold growth in the home.

**Q4: What is *Stachybotrys chartarum* (*Stachybotrys atra*)?**

**A:** *Stachybotrys chartarum* (also known by its synonym *Stachybotrys atra*) is a greenish-black mold. It can grow on material with a high cellulose and low nitrogen content, such as fiberboard, gypsum board, paper, dust, and lint. Growth occurs in the presence of moisture from water damage, excessive humidity, water leaks, condensation, water infiltration, or flooding. Constant moisture is required for its growth. It is not necessary, however, to determine what type of mold you may have. All molds should be treated the same with respect to potential health risks and removal.

**Q5: How common is mold, including *Stachybotrys chartarum* (also known by its synonym *Stachybotrys atra*), in buildings?**

**A:** Molds are very common in buildings and homes and will grow anywhere indoor where there is moisture. The most common indoor molds are *Cladosporium*, *Penicillium*, *Aspergillus*, and *Alternaria*. We do not have accurate information about how often *Stachybotrys chartarum* is found in buildings and homes. While it is less common than other mold species it is not rare.

**Q6: What are the potential health effects of mold in buildings and homes?**

**A:** Mold exposure does not always present a health problem indoors. However, some people are sensitive to molds. These people may experience symptoms such as nasal stuffiness, eye irritation, or wheezing when exposed to molds. Some people may have more severe reactions to molds. Severe reactions may occur among workers exposed to large amounts of mold in occupational settings,

such as farmers working around moldy hay. Severe reactions may include fever and shortness of breath. People with chronic illnesses, such as obstructive lung disease, may develop mold infections in their lungs.

**Q7: Who is most at risk for health problems associated with exposure to mold?**

**A:** People with allergies may be more sensitive to molds. People with immune suppression or underlying lung disease are more susceptible to fungal infections.

**Q8: Does *Stachybotrys chartarum* (*Stachybotrys atra*) cause acute idiopathic pulmonary hemorrhage among infants?**

**A:** To date, a possible association between acute idiopathic pulmonary hemorrhage and *Stachybotrys chartarum* (*Stachybotrys atra*) among infants has not been proved. Further studies are needed to determine what causes acute idiopathic hemorrhage.

**Q9: What if my child has acute idiopathic pulmonary hemorrhage?**

**A:** Parents should ensure that their children get proper medical treatment.

**Q10: How do you get the molds out of buildings, including homes, schools, and places of employment?**

**A:** In most cases, mold can be removed by a thorough cleaning with bleach and water. If you have an extensive amount of mold and you do not think you can manage the cleanup on your own, you may want to contact a professional experienced in cleaning mold in buildings and homes.

**Q11: What should people do if they determine they have *Stachybotrys chartarum* (*Stachybotrys atra*) in their buildings or homes?**

**A:** Mold growing in homes and buildings, whether *Stachybotrys chartarum* (*Stachybotrys atra*) or other molds, indicates a problem with water or moisture. Thus, the first step is to address the water/moisture problem. With that issue resolved, the second step is to clean surfaces with a weak bleach solution. Mold under carpets typically requires removal of carpets. Once mold starts to grow in insulation or wallboard, the only way to deal with it is by removal and replacement. In areas where flooding has occurred, prompt cleaning of walls and other flood-damaged items with water mixed with chlorine bleach, diluted 10 parts water to one part bleach, is necessary to prevent mold growth. Never mix bleach with ammonia. Moldy items should be discarded. The precautions with *Stachybotrys chartarum* (*Stachybotrys atra*) follow the same steps.

**Q12: Are there any circumstances where people should vacate a home or other building because of mold?**

**A:** Decisions about vacating premises have to be made individually. If you believe you are ill because of exposure to mold in a building, you should consult your physician to determine the appropriate action.

### **Q13: How do you keep mold out of buildings and homes?**

**A:** As part of routine building maintenance, buildings should be inspected for visible mold and evidence of water damage. The conditions causing mold (such as water leaks, condensation, infiltration, or flooding) should be corrected to prevent mold from growing.

## **HOW CAN I RESTORE WATER-DAMAGED CARPET?**

*Source: Carpet and Rug Institute*

There is no single procedure for dealing with flood damage in all situations. Each situation is different and must be evaluated by an expert.

Determine whether the floodwater is sanitary, unsanitary, or black water. Only in sanitary conditions should you attempt to clean and restore the carpet yourself. Cleaning professionals should be called in to handle the adverse effects of disease-carrying bacteria contained in unsanitary and black water.

**Sanitary**—may include uncontaminated sink or toilet overflows and flows from ruptured pipes.

**Unsanitary**—includes any water with some degree of biopollutant contamination, such as water from punctured waterbeds and contaminated toilet and dishwasher overflows.

**Black Water**—includes any water that has come into contact with the ground or that contains raw sewage, including, but not limited to, natural flooding. Unfortunately, carpet flooded by black water must be discarded because of the high-level intrusion of bacteria and other pollutants.

Before restoration can begin, you must identify the source of the water flow and stop it. With sanitary water, once the water has been stopped, extraction of excess water from the carpet must begin immediately. To reduce the possibility of fungal growth, the carpet cushion should be discarded. In cases of natural flooding or rising water, the carpet and carpet cushion should be replaced immediately to minimize possible health concerns.

Immediate Steps:

- Quickly remove any furnishings that may be damaged by the intrusion and that may stain or damage the carpet.

- Keep traffic over the wet carpet to a minimum. Moisture can weaken the latex backing in carpet, and excess traffic may cause the backing to separate. Once dry, the backing will regain much of its original strength.
- Use fans to increase ventilation, a vacuum designed to extract water (if available), and dehumidifiers to speed the drying process (only in sanitary conditions).
- To minimize the growth of bacteria and fungi, completely dry the carpet within 24 hours after the elimination of the water source.

Because each situation is different, consult a cleaning professional to determine whether the carpet can be salvaged. Often, a homeowner's insurance agent will hire a cleaning professional for the homeowner. The cleaning professional should extract the excess water, clean and disinfect the carpet, or remove it if necessary.

Additional information is available by telephone from the Carpet and Rug Institute and in the IICRC Standard and Reference Guide for Professional Water Damage Restoration S500-99 document prepared by the Institute of Inspection, Cleaning, and Restoration Certification (see References).

## **REFERENCES AND ADDITIONAL READING**

American Society for Testing and Materials: Building Science Concepts on Moisture

[www.astm.org](http://www.astm.org), "Moisture Analysis and Condensation Control in Building Envelopes - MNL40," 2001, ASTM, West Conshohocken, PA.

American Board of Industrial Hygiene: Certified Associate Industrial Hygienist

[www.abih.org](http://www.abih.org), 6015 West St. Joseph, Suite 102, Lansing, MI 48917-3980

California Department of Health Services:

[www.cal-iaq.org/mold9803.htm](http://www.cal-iaq.org/mold9803.htm), "Indoor Air Quality Info Sheet"

Carpet and Rug Institute

[www.carpet-rug.com](http://www.carpet-rug.com), "Caring for Water-Damaged Carpet," Carpet & Rug Institute, 800-882-8846

Centers for Disease Control and Prevention

[www.cdc.gov/nceh/airpollution/mold/](http://www.cdc.gov/nceh/airpollution/mold/), U.S. Centers for Disease Control and Prevention, 1600 Clifton Rd., Atlanta, GA 30333

[www.cdc.gov/epo/mmwr/preview/mmwrhtml/mm4909a3.htm](http://www.cdc.gov/epo/mmwr/preview/mmwrhtml/mm4909a3.htm), "Update: Pulmonary Hemorrhage/Hemosiderosis Among Infants-Cleveland, Ohio, 1993-1996," MMWR Weekly, March 10, 2000, 49(09):180-4, Centers for Disease Control and Prevention, 1600 Clifton Rd, Atlanta, GA 30333

EPA: Healthy Indoor Air for America's Homes

[www.montana.edu/wwwcxair](http://www.montana.edu/wwwcxair), "Healthy Indoor Air for America's Homes," U.S. Environmental Protection Agency, Office of Air and Radiation Indoor Environments Division, 1200 Pennsylvania Ave., NW, Mail code: 6609J, Washington, DC 20460

EPA: Mold Remediation in Schools and Commercial Buildings

[www.epa.gov/iaq/molds/mold\\_remediation.html](http://www.epa.gov/iaq/molds/mold_remediation.html), "Mold Remediation in Schools and Commercial Buildings," U.S. Environmental Protection Agency, Office of Air and Radiation Indoor Environments Division, 1200 Pennsylvania Ave., NW, Mail code: 6609J, Washington, DC 20460

EPA: Mold Resources

[www.epa.gov/iaq/pubs/moldresources.html](http://www.epa.gov/iaq/pubs/moldresources.html), EPA's Mold Resources. U.S. Environmental Protection Agency, Office of Air and Radiation Indoor Environments Division, 1200 Pennsylvania Ave., NW, Mail code: 6609J, Washington, DC 20460

FEMA: Flood Restoration

[www.redcross.org/services/disaster/0,1082,0\\_570\\_,00.html](http://www.redcross.org/services/disaster/0,1082,0_570_,00.html), "Repairing Your Flooded Home," FEMA L-198, August 1992, FEMA P.O. Box 2012, Jessup, MD, 20794-2012

IICRC: Institute of Inspection, Cleaning, and Restoration Certification

"Standard and Reference Guide for Professional Water Damage Restoration S500-99," Institute of Inspection, Cleaning, and Restoration Certification, 2715 E. Mill Plain Blvd., Vancouver, WA 98661, 360-693-5675.

Institute of Medicine: Conference Proceedings on Asthma

[www.nap.edu](http://www.nap.edu), "Clearing the Air: Asthma and Indoor Air Exposures," 2000, Institute of Medicine, National Academy Press, 2101 Constitution Ave., NW, Washington, DC.

Johns Hopkins University Asthma and Allergy: Mold Control in the House

[www.hopkins-allergy.org/rhinitis/therapeutics-house.html](http://www.hopkins-allergy.org/rhinitis/therapeutics-house.html), Johns Hopkins Asthma and Allergy Center, 5501 Hopkins Bayview Cir., Baltimore, MD.

National Association of Home Builders: Foundation and Groundwater Issues

[www.builderbooks.com](http://www.builderbooks.com), "Residential Water Problems Prevention and Solutions", Home Builder Press, 1994.

NAHB Research Center: Weather Barrier

["Moisture Protection of Wood Sheathing."](#)

New York City Department of Health

[www.nyc.gov/html/doh/html/epi/moldrpt1.html](http://www.nyc.gov/html/doh/html/epi/moldrpt1.html), "Guidelines on Assessment and Remediation of Fungi in Indoor Environments."

University of Minnesota

[www.dehs.umn.edu/iaq/fungus/](http://www.dehs.umn.edu/iaq/fungus/), Environmental Health and Safety, Fungal Abatement Safe Operating Procedure, Glossary, Hidden Fungi in Buildings, Investigation/Interpretation of Results, Links, Managing Water Infiltration, Pictures, References.