



**North Carolina Department of Health and Human Services
Division of Public Health
Occupational and Environmental Epidemiology**

Mold and Human Health

Mold is a term used to describe a type of fungus that is an often fuzzy-looking growth that appears on the surface of organic materials in damp conditions, both outdoors and indoors. Molds may be gray, black, green, yellow, orange or various other colors, and may have a velvety or wooly texture.

Like other fungi, molds produce tiny spores in order to reproduce. Mold spores continually waft through the air, both indoors and out-of-doors. When mold spores land on a damp spot, they may begin growing and digesting whatever they are growing on in order to survive. Indoors, molds can grow on wood, paper, fabrics, carpet, foods and other organic materials.

Molds are a natural part of the environment, but human health problems may result when people are exposed to large amounts of mold, particularly indoors. Inhaling excessive quantities of airborne mold particles or spores may lead to allergic illness, trigger asthma, cause respiratory infections, or bring about toxic effects from certain chemicals in the mold cells.

When excessive moisture or water accumulates indoors, mold growth will often occur, particularly if the moisture problem remains undiscovered or unaddressed. There is no practical way to eliminate all mold and mold spores indoors. However, indoor mold growth can be controlled by controlling moisture.

Table of Contents:

- I. Health Effects of Indoor Mold
- II. Where Does Mold Grow?
- III. Conditions that Promote Mold Growth
- IV. Cleanup and Removal of Mold
 - (A) Health Precautions During Mold Cleanup and Removal
 - (B) Cleaning Moldy Non-porous and Semi-porous Materials
 - (C) Removing Moldy Porous Materials
- V. Hiring a Mold Consultant or Contractor
- VI. Websites for More Information

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I. Health Effects of Indoor Mold

Exposure to mold can occur when airborne mold cells, mostly spores, are inhaled. We breathe in these cells every day, indoors and out. Usually these exposures do not present a health risk. But when exposure is great, some individuals, particularly those with allergies and asthma, can experience illness that could be mild to serious or anywhere in between. The following is a description of the health problems that can be caused by exposure to mold.

Allergic Illness

When mold cells are inhaled and land in the respiratory tract, the body's immune system's response to those invading cells can cause allergic illness. The immune system tries to destroy the mold as it would an agent, like a flu virus, that might cause infection. In a relatively small portion of the population (about 10 percent of people in the U.S.), the immune system overreacts and causes the allergic response that results in symptoms such as runny nose, scratchy throat and sneezing. Most of us know this allergic illness as "hay fever" or "allergic rhinitis."

Asthma

Asthma (see EPA Web page, <http://www.epa.gov/iaq/asthma/about.html>) is a lung disease in which the airways that carry oxygen to the lungs can partially close, causing breathing difficulties ranging from mild (such as a dry cough) to life-threatening (inability to breathe). North Carolina is in the midst of what is being called a world-wide asthma epidemic. A recent survey of North Carolina middle school children revealed that 10 percent had been diagnosed with asthma and another 17 percent had asthma symptoms that had never been diagnosed. More than half of asthmatics have respiratory allergies, often to mold. Molds can trigger asthma episodes in sensitive asthmatics.

Infection

Some mold species can cause respiratory infection when the live mold invades the tissues of the lungs or respiratory tract. This is not a significant risk for healthy people, but can be dangerous for individuals with severely weakened immune systems.

Toxic Effects

Very large doses of certain molds, whether inhaled or ingested, can result in poisoning caused by toxins, called mycotoxins, in the mold cells. It is not clear whether an individual can receive a high enough exposure to mold growing indoors to experience these toxic effects.

One particular type of mold that has been recently highlighted in the media is *Stachybotrys chartarum* (also known as *Stachybotrys atra*). *Stachybotrys* is a greenish-black mold that grows on materials with high cellulose content (drywall, wood, paper, ceiling tiles) that are chronically wet or moist. It is one of several molds that can produce mycotoxins under certain environmental conditions. The health effects of breathing mycotoxins are not well understood, but we do know that most molds can present some health risks, such as allergic reactions. Therefore, any mold growth in a building should be cleaned up, regardless of the type of mold. For additional information on this issue see *Questions and Answers on Stachybotrys chartarum and other molds* on the National Center for Environmental Health website (<http://www.cdc.gov/nceh/airpollution/mold/stachy.htm>).

II. Where Does Mold Grow?

Mold spores may be found lying dormant on almost every surface in a building. Unless large numbers of spores become airborne, there is usually little problem. However, when mold spores are on a surface with an appropriate moisture content, nutrients, and temperature, the spores will germinate and mold will grow. The key to identifying locations where mold is likely to grow is finding where these conditions exist, have occurred, or are likely to develop.

Mold should not grow indoors unless there are moisture problems in the building. Obvious causes of moisture problems include occupant-generated sources, floods, roof leaks, and problems with drainage or plumbing. A less obvious source of moisture is the effect of temperature gradients (temperature differences), especially in locations where relatively warm and moist air comes in contact with relatively cool surfaces. These conditions can cause water vapor to condense on building surfaces, just as it does on a glass of ice water on a warm, humid day.

Most molds must get their food from the environment, living and feeding on dead organic matter. Outdoors, molds are very important in decomposing organic materials and recycling nutrients. Indoors, many building components and contents contain materials that are excellent food sources for mold, such as wallpaper glue, some paints, greases, paper, textiles, and wood products. Indoor dusts may contain fibers, dead skin cells, and other organic matter that can serve as a food source for mold when adequate moisture is available.

Temperature also affects mold growth. Different types of mold have minimum, optimum and maximum temperature ranges for growth. Many fungi grow well at temperatures between 60 and 80 degrees Fahrenheit, which are also ideal temperatures for human comfort. In addition, as mentioned above, temperature gradients often produce the moisture needed for mold growth.

In the summer, when air-conditioning is in use, mold growth can occur in buildings where the cooling systems are oversized, undersized or poorly maintained. Unplanned air flow in buildings can also create conditions favorable to mold growth. A competent heating and air conditioning contractor should be able to address these issues.

In the winter, when buildings are heated, mold often grows in cold, uninsulated exterior windows and walls, including uninsulated closets along exterior walls where building surfaces are generally cold relative to the indoor air temperature.

III. Conditions That Promote Mold Growth

All of the conditions needed for mold growth (food sources and appropriate temperatures) are present in the indoor environment with the exception of adequate moisture. Prevention of mold growth indoors can not be achieved without proper moisture control. The following are some of the moisture problems that cause indoor mold growth.

Water Intrusion

Rainwater can enter a building through leaks in walls, windows or the roof. Surface or ground water may enter when there is poor foundation drainage. Flooding can, of course, cause catastrophic intrusion. In buildings that have slab construction, water can seep or wick up through the cement floor causing mold to grow on carpet pads or carpet backing. The building envelope (walls, windows, floors, roof, etc.) must be well maintained to prevent water from coming in, both to prevent mold growth and to maintain the structural integrity of the building.

Water Vapor

When relative humidity (a temperature-dependent measure of water vapor in air) becomes elevated indoors, building materials and furnishings absorb the moisture. Those damp materials can then provide a good place for mold to grow. If there are no cold condensing surfaces and the relative humidity (RH) is maintained below 60 percent indoors, there will not be enough water in those materials for mold to grow. However, if the RH stays above 70 percent indoors for extended periods of time, mold will almost certainly grow.

In the summer, air conditioning can de-humidify indoor space. But if the system is too large or too small for the space it serves, the cooling system can create high humidity by cooling without removing water vapor. A properly sized and maintained system will dehumidify and cool a building.

When there are cold surfaces in a building, water vapor can condense on those surfaces, just as water condenses on the outside of a glass of ice water. Insulation of exterior walls can prevent condensation and mold growth during the winter.

You should always be mindful of indoor sources of water vapor that can be problematic. Clothes dryers must be vented to the outdoors. Unvented gas or kerosene space heaters can generate enormous amounts of water vapor (as well as other air contaminants), and should be used sparingly and never as a primary heat source. Always run the bathroom exhaust fan when showering or bathing, and make sure the vent is exhausted to outdoors. A properly vented kitchen exhaust fan can remove steam created during cooking.

IV. Cleanup and Removal of Mold

The first step in addressing any mold growth problem in a building is identifying and correcting moisture source(s) (see *Where Does Mold Grow?*). If moisture problems are not corrected, then any mold cleanup or removal that takes place will most likely be only a short-term solution; at some point the mold growth will recur. It is critical to control moisture at the beginning, during, and at the end of a mold growth removal project.

One of the most common misconceptions about mold is that it can be removed by spraying the surfaces with products such as disinfectants, biocides or cleaners. That will not take care of the problem because the allergenic and toxic properties of mold are not removed by using such products. Whether viable (living) or nonviable (dead), mold spores and other parts of the mold, when they get into the air, still present a health risk to exposed individuals.

While disinfectants and biocides may kill mold spores and take away their ability to reproduce, these products should not be used alone in addressing a mold growth problem. Either the mold must be completely removed from the affected material, or the mold-contaminated material must be completely removed from the building.

In determining which materials can be cleaned and what should be removed, the two important factors are how porous (absorbent) the material is and how extensive the mold growth is. Generally, non-porous materials (such as metals, glass and hard plastics) and semi-porous materials (wood, plaster and concrete) that are visibly moldy but structurally sound can usually be cleaned and reused. Moldy porous materials (carpeting, wallboard, ceiling tile, wallpaper, fabric, upholstered furniture, mattresses) should usually be discarded, since they absorb and hold moisture, may be internally moldy, and cannot be completely cleaned and thoroughly dried.

Cleanup and mold removal activities can expose people to mold particles and other hazards, so it is important to wear protective equipment and follow procedures safely. For complete instructions, see the sections below:

- Health Precautions during Mold Cleanup and Removal
- Cleaning Moldy Non-porous and Semi-porous Materials
- Removing Moldy Porous Materials

Air duct systems in buildings can also become contaminated with mold. Air duct systems can be constructed of bare sheet metal, sheet metal with exterior or interior fibrous glass insulation, or made of entirely out of fibrous glass (ductboard). If mold growth has occurred on fibrous glass or other porous surfaces, then effective cleaning will not be possible and the ductwork and/or insulation will need to be discarded. Mold growth on metal ductwork may be cleaned and disinfected following the instructions for non-porous materials below. For additional details on addressing air duct cleaning see *Should You Have the Air Ducts in Your Home Cleaned?*, a publication of the Environmental Protection Agency (EPA), available on the Web at <http://www.epa.gov/iedweb00/pubs/airduct.html>.

(A) Health Precautions during Mold Cleanup and Removal

When approaching a mold removal and cleaning project, one of the most important considerations is the potential risk from mold exposure (see *Health Effects of Indoor Mold* above). Mold counts in the air can be 10 to 1,000 times higher than normal during a removal or cleaning project. Because of the potential health risks from mold exposure it is advisable, particularly for larger (greater than 30 square feet) contamination situations, to contact a mold remediation contractor (see *Hiring a Mold Consultant or Contractor* below). Individuals who have allergies, asthma or respiratory disease; are immunosuppressed; or have other health problems should not take part in a mold removal/cleaning project or be in the general area of the project.

To minimize exposure and/or potential health risks from conducting a mold remediation project, take the following precautions:

- Wear respiratory (nose and mouth) protection when handling or cleaning moldy materials. The minimal type of breathing mask, or respirator, that should be used for protection from mold particles is an "N-95" particulate respirator approved by the National Institute for Occupational Safety and Health (NIOSH).
- Wear protective clothing that can be laundered or discarded after the project.
- Wear gloves and eye protection.
- Follow the recommended mold cleaning and removal steps to minimize dust dispersal (see *Moldy Non-porous and Semi-porous Materials* and *Moldy Porous Materials*).

Additional details and steps for addressing various types and sizes of mold remediation projects can be found in *Guidelines on Assessment and Remediation of Fungi in Indoor Environments* on the New York City Department of Health web site, <http://www.nyc.gov/html/doh/html/epi/moldrpt1.shtml>.

(B) Cleaning Moldy Non-porous and Semi-porous Materials

When cleaning non-porous (metals, glass, hard plastic) and semi-porous (wood, plaster, concrete) materials, follow these steps:

- Wear protective equipment and follow safety procedures (see *Health Precautions during Mold Cleanup and Removal* above).
- First, wet the moldy area down by spraying lightly with a water-and-detergent solution to help keep mold dust and spores from getting into the air. A high-efficiency particulate air-filtered (HEPA) vacuum cleaner can also be used to help in removing surface mold growth and removing the spores from nearby materials.
- Using a non-ammonia soap or detergent and hot water or commercial cleaner, thoroughly scrub all moldy surfaces.
- Rinse the scrubbed surfaces with clean water. A wet-dry vacuum may be used to collect excessive water.
- After cleaning, a disinfectant solution such as household bleach and water ($\frac{1}{4}$ to $1\frac{1}{2}$ cup liquid chlorine bleach to one gallon of water), can be applied to the affected surface. Never mix bleach with ammonia - toxic gases can be created. Follow all label directions on all products used in this step. Make sure the area is well-ventilated when using disinfectant solutions. For this step to be most effective, the disinfectant solution should be allowed to stay on the surface for 6 to 8 hours and the solution should be allowed to dry naturally.
- After cleaning and disinfecting, the affected surfaces should be dried out as quickly as possible. The use of fans and dehumidifiers may speed up this process. If materials are not dried properly, the mold is very likely to re-grow. Moisture levels in wood should be less than 12 to 15 percent prior to rebuilding, painting, etc.

(C) Removing Moldy Porous Materials

Porous materials such as carpets/padding, ceiling tiles, insulation, wallboards (gypsum board or plasterboard), upholstered furniture and bedding that contain more than a small area of mold should usually be removed from the building and discarded. Since these types of materials can readily absorb significant amounts of moisture, the mold growth can be much more pervasive, and deep cleaning of embedded mold can be very difficult and time-consuming. Also, when porous building products become wet they tend to lose their structural integrity.

The following steps should be taken when removing such items:

- Wear protective equipment and follow safety procedures (see *Health Precautions During Mold Cleanup and Removal* above).
- Lightly mist the mold with water and detergent solution to help control dust dispersal during the removal. Avoid adding excessive moisture that can result in additional mold growth problems.
- Bag or otherwise containerize (poly-wrap) mold-contaminated debris when transporting from the work site to the disposal site, such as a landfill.
- After removing the moldy materials, the work area should be cleaned by a damp method, such as mopping, with a detergent solution and/or vacuumed with a high-efficiency particulate air-filtered (HEPA) vacuum cleaner.
- The final step in such a project is to assure that the remaining materials are adequately dried out prior to reinstalling or replacing building materials.

V. Hiring a Mold Consultant or Contractor

There are no federal regulations covering professional services in the general field of indoor air quality (IAQ). However, there are some steps that you can take to ensure that you select the best assistance available. A qualified IAQ consultant should have appropriate experience and be able to demonstrate a broad understanding of indoor air quality problems and the conditions that can lead to them. Ask questions-it's your money!

1. Proposal

Ask consultants to explain the nature of the diagnosis and/or mitigation they will perform. This explanation should include the sequence of the investigation. A general systematic approach is usually more effective than relying on extensive air testing. The proposal should emphasize observations rather than measurements. Beware of contractors and consultants who want to conduct air sampling as a first step in determining the extent of your mold problem. There are currently no uniformly accepted standards that quantify how much or what kind of airborne mold is acceptable. A thorough visual inspection is the first and most important way to assess water damage and mold growth problems.

2. Experience

Ask how much and what type of IAQ work the firm has done. Identify the personnel who will be involved in your case, their experience and their qualifications. Request and contact references to verify that the consultant has helped them solve their IAQ problem.

Since some mold growth problems can be related to water or moisture intrusion, you may

want to consider using a company that has expertise in this area. These companies can be found in the local phone book under fire and water damage restoration. You can also check with your insurance company for a listing of these companies in your area.

3. Interview

A firm needs a preliminary understanding of the facts about what is going on in your building to evaluate if it has the skills necessary to address your concerns. Competent professionals will ask questions about your situation in order to determine if they can offer services that will assist you. Be alert and check for conflicts of interest.

Find out if the contractor belongs to trade groups and follows industry standards/guidelines in conducting mold evaluation and remediation. Two groups that provide training, certifications, and guidance for water damage restoration contractors are:

- Association of Specialists in Cleaning and Restoration (ASCR)
(<http://www.ascr.org>)
- The Institute of Inspection, Cleaning and Restoration Certification
(<http://www.iicrc.org>)

4. Contract

The scope of the project should be identified. Communication between you and the consultant is essential, whether in person or by telephone. The frequency of status reports and meetings should be spelled out. The schedule, costs, and written report should be described.

5. Conflict of Interest

If you hire a consultant to investigate and identify a problem in a building, that should be all the consultant does. Do not hire a consultant who also provides remediation services. Although most consultants and contractors are honest, some may interpret environmental results (which are often somewhat uncertain) to steer you toward their services.

Last but not least, make sure the occupants of the building that is being evaluated are kept informed of the progress on the problem and are involved in the process. Oversee the work and ask questions that will help you assure that the work is properly performed.

For additional information on hiring an IAQ consultant:

- IAQ Publications List, U.S. Environmental Protection Agency (EPA)
(<http://www.epa.gov/iaq/pubs>)
- *Guidelines For Selecting An Indoor Air Quality Consultant*, American Industrial Hygiene Association (http://www.cal-iaq.org/guide_aiha_9901.htm)
- For schools: *Hiring Professional Assistance*, American Industrial Hygiene Association
(http://www.cal-iaq.org/guide_ak_9901.htm)

VI. Websites for More Information on Mold and Indoor Air Quality Issues

Adverse Human Health Effects Associated with Molds in the Indoor Environment, American College of Occupational and Environmental Medicine (<http://www.acoem.org/guidelines/article.asp?ID=52>)

After the flood...getting back into your home safely, N.C. Department of Health and Human Services (http://www.dhhs.state.nc.us/docs/hurricane_afteraflood.htm)

American Conference of Governmental Industrial Hygienists (<http://www.acgih.org/home.htm>)

Asthma information, U.S. Environmental Protection Agency (EPA) (<http://www.epa.gov/ebtpages/humahealththeeffectsasthma.html>)

A Brief Guide to Mold in the Workplace, Occupational Safety & Health Administration (OSHA) (<http://www.osha.gov/dts/shib/shib101003.html>)

Controlling Mold Growth in the Home, Kansas State University Cooperative Extension Service (<http://www.oznet.ksu.edu/library/hous2/MF2141.PDF>) (PDF file; requires Adobe Acrobat Reader)

The Facts About Mold: For Everyone, American Industrial Hygiene Association (AIHA). Consumer information & access to list of consultants (<http://www.aiha.org/GovernmentAffairs-PR/html/mold-consumer.htm>)

Going Back In and Being Safe: Health and Safety Risks of Entering Flooded Buildings, N.C. Department of Health and Human Services (in English: <http://www.dhhs.state.nc.us/docs/hurricanesafe.htm>. Spanish version: *Riesgos a la Salud y Seguridad al Entrar en Edificios Inundados*, <http://www.dhhs.state.nc.us/docs/hurricaneriesgos.htm>.)

Guidelines for Re-Occupancy of Flooded Buildings: Controlling Exposure to Biological Building Contaminants, N.C. Department of Health and Human Services (<http://www.dhhs.state.nc.us/docs/hurricaneoccupant.htm>)

Guidelines For Selecting an Indoor Air Quality Consultant, American Industrial Hygiene Association (AIHA) (http://www.cal-iaq.org/guide_aiha_9901.htm)

Guidelines on Assessment and Remediation of Fungi in Indoor Environments, New York City Department of Health & Mental Hygiene (<http://www.nyc.gov/html/doh/html/epi/moldrpt1.shtml>)

Hiring Professional Assistance (for schools), American Industrial Hygiene Association (AIHA) (http://www.cal-iaq.org/guide_ak_9901.htm)

Indoor Air - Mold, Environmental Protection Agency (EPA) site has books on mold and moisture in homes as well as schools and commercial buildings. Also includes removal of mold. (<http://www.epa.gov/iaq/molds/index.html>)

Indoor Air Quality, N.C. Division of Public Health (<http://www.epi.state.nc.us/epi/air.html>)

Indoor Mold, Toxigenic Fungi, and Stachybotrys chartarum: Infectious Disease Perspective, Clinical Microbiology Reviews, Jan. 2003 (<http://cmr.asm.org/cgi/content/full/16/1/144>)

Mold, Centers for Disease Control and Prevention (CDC) (<http://www.cdc.gov/nceh/airpollution/mold/>)

Mold & Human Health, N.C. Division of Public Health
(<http://www.epi.state.nc.us/epi/oii/mold/healtheffects.html>)

Mold Links, Centers for Disease Control and Prevention (CDC). Includes links to other national and state sites (<http://www.cdc.gov/nceh/airpollution/mold/links.htm>)

Mold/Moisture Resource List, Minnesota Department of Health
(<http://www.health.state.mn.us/divs/eh/indoorair/mold/links.html>)

Mold Resources, Environmental Protection Agency (EPA)
(<http://www.epa.gov/iaq/molds/moldresources.html>)

Mold, dust mites, fungi, spores, and pollen: Bioaerosols in the human environment, N.C. State University Cooperative Extension Service (<http://www.ces.ncsu.edu/depts/fcs/housing/pubs/fcs3605.html>)

Mold in My Home: What Do I Do? California Department of Health Services
(<http://www.dhs.ca.gov/ps/deodc/ehib/EHIB2/topics/Moldhome%20Eng.html>)

Molds in Indoor Workplaces, California Department of Health Services Hazard Evaluation System and Information Service (<http://www.dhs.ca.gov/ohb/HESIS/molds.pdf>) (PDF file; requires Adobe Acrobat Reader)

Molds in the Environment, Centers for Disease Control and Prevention (CDC)
(<http://www.cdc.gov/nceh/airpollution/mold/moldfacts.htm>)

Mold Remediation in Schools and Commercial Buildings, U.S. Environmental Protection Agency (EPA)
(http://www.epa.gov/iedweb00/molds/mold_remediation.html)

Questions and Answers on Stachybotrys chartarum and other molds, National Center for Environmental Health (<http://www.cdc.gov/nceh/airpollution/mold/stachy.htm>)

Should You Have the Air Ducts in Your Home Cleaned? U.S. Environmental Protection Agency (EPA)
(<http://www.epa.gov/iedweb00/pubs/airduct.html>)

Testing for Mold, Minnesota Department of Health
(<http://www.health.state.mn.us/divs/eh/indoorair/mold/moldtest.html>)

Consultants and laboratories

The Facts About Mold: For Everyone, American Industrial Hygiene Association (AIHA). Consumer information & access to list of consultants (<http://www.aiha.org/GovernmentAffairs-PR/html/mold-consumer.htm>)

Environmental Microbiology Accredited Laboratories (list). American Industrial Hygiene Association (AIHA) (<http://www.aiha.org/GovernmentAffairs-PR/html/mold-consumer.htm>)

Tenant Issues

Landlords' Maintenance and Repair Duties: Your Rights as a Residential Tenant in North Carolina, N.C. Department of Justice
(<http://www.ncdoj.com/DocumentStreamerClient?directory=CPTipAlert/&file=Landlord-tenant%20booklet.pdf>) (PDF document; requires Adobe Acrobat Reader)