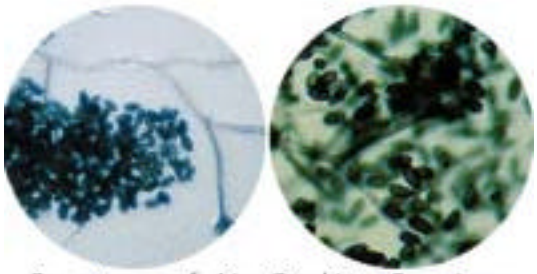
Mold Awareness

Training Manual



Courtesy of Air Quality Services

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Mold Awareness & Inspection

Introduction

A few years ago, few people had ever heard of "Toxic Mold". Although not many people know how to pronounce Stachybotrys, just about everyone thinks they know what it means. There is a news story about toxic mold on the TV, in the newspapers, or on the Internet almost daily. There are stories of $100 million lawsuits, of $18 million mold verdicts, people moving out of their homes and leaving behind all their worldly possessions, and people with mold colonies in their lungs. In Sacramento alone, three major apartment complexes have had outbreaks resulting in many apartments being condemned and hundreds of tenants being relocated or evicted. The cost of relocating can be significant, because other apartment communities will not let these people move in without a certification that their belongings are free of mold. The media frenzy that has evolved has created an abundance of misinformation that is leaving many people in a panic.

Mold is everywhere, so why is there such a concern? The potential impact of mold growth indoors is hard to define. It can result in serious health problems, some of which can be long term. It will reduce the property value of the home. Sometimes even if the mold has been abated, there is a stigma attached to it and the fear of the return of mold will limit the value. It may result in a building being condemned for code violations. It raises environmental justice issues because poor and underprivileged families often live in older homes or apartments that are not well maintained and prone to water and mold problems.

There is also a significant cost associated with mold growth. Mold abatement can cost thousands of dollars depending on the severity of the problem. Because of the potential hazard posed by mold, personnel that are trained in the handling of biohazard materials should be involved with mold abatement. Amplified mold growth indoors is usually caused by excessive moisture, which could be related to a construction defect. It is therefore essential that any mold growth be properly remediated. A mold problem that is not taken care of early on will cost much more to resolve later.

Given all the tangible and intangible costs associated with mold growth, there are also very serious liability risks faced by many different parties. Mold litigation has become one of the fastest growing fields of litigation. Everyone with a mold problem in his or her home or who has suffered exposure to high levels of mold is looking for someone to blame. Currently there are very few regulations regarding the identification, testing, or remediation of mold problems in California. This makes many different parties

vulnerable to suits filed by people who are seeking compensation for their health problems, abatement costs, or lost property value.

Landlords have been sued for the condition of their rental units. Concerned parents for mold in schools are suing school districts. Employers have been sued by their employees for mold growth in the office buildings and exposure to molds on the job, as in the case of renovation contractors who may work with water damaged homes. Insurance companies have been sued for failure to properly repair water damage.

Home Builders have been sued for construction defects in the houses they have built, which leads to suits against the subcontractors involved. Could home inspectors or pest inspectors be liable for failing to recognize a mold problem of moisture problem that will lead to a mold problem in the future?

The number of homes with mold problems is steadily increasing. The houses that are built now are much more susceptible to the mold problems than the houses built 30 years ago. The energy crisis in the 70's has lead to the creation of tighter building envelopes, which do not provide as much ventilation with outside air and trap moisture inside. Building materials are now organic based and safer for the environment, but also a better food source for mold. Homes are also being built on former plains, swampland, and proper quality land, which may cause more moisture problems.

Most new homes are also track homes, which may have an increased potential for mold growth to occur. With track homes, the building process is speeded up, and sometimes slab foundations do not cure properly before the home is built. Many subcontractors are often involved in track homes, so there is less control over the building conditions, which can lead to construction defects. Homes are also built all year round; so building materials are exposed to rain causing mold growth before the house is even finished.

This course is intended to provide you, the home inspector, with an understanding of the effects of mold growth and the types of conditions that lead to mold growth. With this knowledge, you can take pro-active steps during the construction process to limit the opportunity for molds to grow in the homes you build and recognize existing mold problems so you can remedy them early, thereby reducing the cost and time needed for the abatement and minimize future liability.

Mold Biology

Molds are types of fungi, which are not plants, or animals, but a separate kingdom of their own. They feed on dead, organic material and play an important ecological role by decomposing dead leaves, grass, and other plant material so they do not build up outside.

They reproduce through spores, which become airborne and spores are very common in the air both inside and outside. These are microscopic and are inhaled into our lungs along with pollen, dust and other tiny particles in the air.

Molds produce mycotoxins, which are chemicals associated with growth, self-defense, and metabolism. These mycotoxins can be found on the surface of mold spores and are inhaled into the lungs along with the spores.

In order for mold to grow it needs a **food source** with a high organic content. This includes wood, paper, cotton, wicker, and other plant-derived materials. Non-organic material, like porcelain and tile are not food sources for mold. When mold is found on these surfaces, as in bathrooms or sinks, it is usually feeding on other organic material that has accumulated on the surface. Thus mold growth in toilets, sinks, or showers can generally be prevented through regular cleaning or maintenance.

Mold also needs **moisture** to grow. This moisture can come from leaks, floods, condensation, steam, or from high humidity. If mold is present on a surface, then it either currently or in the past had access to moisture. As a home inspector, this is important to know so that you can evaluate any possible structural issues with a home that may be creating a moisture source and allowing mold to grow. Sometimes the source of the moisture may not be obvious, *but it has to be there*.

If mold growth is found on a wall it may be the result of a roof or pipe leak. If it is on an exterior wall then there may be water intrusion from outside or there may not be enough insulation so that condensation is occurring on the wall surface inside. The moisture source may not always be from a structural or design problem with the building. It may be due to human activity inside, like steam from showers or cooking, a spilled fish tank, or a leaking waterbed.

The key to preventing mold grow indoors is to limit the opportunities for moisture to come into contact with potential food sources for mold.

Mold Facts

Molds and fungi are simple, microscopic organisms, found virtually everywhere, indoors and outdoors. Molds and fungi can be found on plants, dry leaves, and other organic material. Molds and fungi play an important role in the environment by breaking down dead, organic material. Mold and fungi spores are very tiny and

lightweight, allowing them to travel through the air. Mold growths can often be seen as a form of discoloration ranging from white to pink and from green to brown and black.

Molds occur in nature, and as such, are always present in the air at ambient levels. Although airborne levels vary according to locale and current environmental conditions, most individuals will not suffer adverse health effects from exposure to background levels. Sometimes, though, conditions indoors can be favorable for fungal growth resulting in increased levels of airborne fungal spores, which can overwhelm the body's natural defenses. Inhalation of such elevated levels of airborne spores can result in allergic or toxic responses. Although infection can occur in an otherwise healthy individual, those most susceptible include infants, children, the elderly, and immune compromised individuals such as those undergoing chemotherapy or suffering from liver disease. The health effects from molds depend on the length and level of exposure (chronic vs. acute) and on individual sensitivity. Health effects from exposure to molds can be divided into four general categories: infection, toxicosis, allergy and irritation.

Infection

There is now over 100 species that are known to cause infection in humans. The three classifications of infection cause by fungi are systematic, opportunistic, and dermatophytic.

1. ***Systematic Infection*** is usually initiated when fungal spores are inhaled. A large minority of these infections are self-limiting and produce minimal or no symptoms. However, immune suppressed individuals may develop chronic localized infections that may disseminate throughout the body, possibly becoming fatal.
2. ***Opportunistic Infection*** is generally limited to immune suppressed individuals where infection is secondary to a primary disease. These fungi can thrive on both living and dead substrates for nutrients.
3. ***Dermatophytic Infection*** is cause by a group of fungi that infect the hair, skin and nails. Infection usually occurs through direct contact with an infected individual. Transmission to humans from an environmental source is rare although outbreaks from soil have been reported.

Toxicosis

Many fungi produce toxic metabolites called mycotoxins. The health effects from exposure to the levels of mycotoxins that may be encountered in contaminated indoor environments are not yet completely known. However, dramatic toxic and carcinogenic effects have been reported for animals and humans exposed to high levels of mycotoxins in laboratory studies. Generally mycotoxins are nonvolatile and exposure usually occurs only after disturbance of a contaminated source. Symptoms of exposure may include headache, nosebleeds, dermatitis, and immune suppression.

Allergy

Allergenic response is the most common symptom associated with exposure to elevated levels of fungal spores or mycelial fragments. Any fungus can be allergenic, producing antigenic proteins and polysaccharides that can cause allergic reactions in sensitive individuals. These reactions may be similar to those caused by pollen and may be seasonal in nature. Many people experience allergic responses in the fall when outdoor levels of mold are typically high.

Irritation

Fungi produce volatile organic compounds during degradation of substrates that cause the "moldy" odor associated with fungal contamination. These compounds can be irritating to mucous membranes causing headaches and other symptoms due to the decaying plant material.

Some of the common molds known to cause health problems include species of *Stachybotrys, Penicillium, Aspergillus, Fusarium, Alternaria,* and *Cladosporium.* These molds, with the exception of *Stachybotrys,* are very common outdoors.

Health Effects Of Mold Exposure

Molds are very common in nature and are to some extent always present in both indoor and outdoor air. Humans have a natural tolerance to molds and moist individuals will not suffer adverse health effects from exposure to background levels of mold spores. Mold growth indoors can cause indoor levels to increase to elevated levels, a condition called mold amplification. Inhalation of a large number of mold spores can overwhelm the body’s natural defenses causing adverse health effects.

Allergic responses are the most common health problems associated with exposure to elevated levels of mold spores. These reactions may be similar to those of hay fever or exposure to high

levels of pollen, such as headaches, sinus problems, congestion, sore throats, or coughing. These effects may be seasonal in nature. Many people experience allergic responses to molds in the fall when outdoor levels of molds are typically high.

Molds can also produce mycotoxins, which are chemicals associated with growth, digestion, and self-defense. Mycotoxins can be toxic to other organisms. Antibiotics like penicillin are made from mycotoxins that kill bacteria. Some mycotoxins can be toxic to humans and can cause very serious health problems. Mycotoxins can enter the body via inhalation, skin absorption, or ingestion. These chemicals are found on the surface of the spores and can be hazardous even if the mold spore is dead. Different mold species produce different mycotoxins, which can cause various reactions in exposed individuals. One mold called Aspergillus versicolor produces trichothecene toxins that are believed to cause neurological problems, such as memory loss, mood changes, constant headaches and trouble concentrating.

Exposure to mold spores and their mycotoxins can lead to a variety of non-specific health problems such as:

- Sinus problems
- Respiratory problems (wheezing, coughing, difficulty breathing)
- Headaches
- Cold and flu-like symptoms (fever, muscle aches, fatigue)
- Sore throats
- Eye irritation
- Frequent bloody noses

The types of health problems that develop depend on a variety of factors such as the length and amount of exposure and the mold growth conditions. Health symptoms may develop from chronic exposure and the mold growth conditions. Health symptoms may develop from chronic exposure at slightly elevated levels over a long period of time, or from acute term exposure at very high levels, like those that occur during mold abatement. The growth conditions of the mold, such as the organic content of the food source, temperature, and the amount of moisture present affects the production of mycotoxins, which in turn affects exposure to the toxins.

The greatest factor affecting the development of health problems is individual sensitivity. Some people are naturally more sensitive to the molds than others. When a family is living in a home with elevated levels of mold spores, often only one or two family members will suffer any health problems while the other family

members experience no ill effects. Individuals that are most susceptible include children, the elderly, and the immune-compromise patients, such as those undergoing chemotherapy or suffering from liver problems.

Mold exposure may be especially hazardous to young infants. It is believed that the Stachybotrys mold may have caused the death of 12 infants and the hospitalization of 37 infants in the Cleveland area of Ohio. These infants were hospitalized for pulmonary hemosiderosis, or bleeding of the lungs, which caused the infants to drown in their own blood. These infants all came from homes that had suffered recent flood damage and had growth of Stachybotrys in their home. The Centers for Disease Control is currently reviewing the data and has said that the association is not conclusive.

In most cases, the mold induced health symptoms will diminish upon removal from the environment with mold. Many doctors, however, believe that people having been exposed to high levels of molds have an increased sensitivity to them so in the future it takes less exposure to molds to develop the same symptoms. In some cases, exposure to high levels of molds can lead to scarring of the lungs or the development of asthma, especially in children, which can have long-term effects.

If a person suspects that they are being or have been exposed to high levels of molds and they are concerned about health problems, they should consult a qualified physician familiar with respiratory problems. If they have had testing done and have any laboratory data, they should bring the data with them to the doctor. While there are many molds that have the potential to be hazardous, only a physician can decide if mold is causing a particular individual's health symptoms or determine if the mold exposure may have any long-term effects.

Common Symptoms of Health Effects

- Respiratory problems, such as wheezing, and difficulty in breathing
- Nasal and sinus congestion
- Eyes-burning, watery, reddened, blurry vision, light sensitivity
- Dry, hacking cough
- Sore throat
- Nose and throat irritation
- Shortness of breath
- Skin irritation
- Central nervous system problems (constant headaches, memory problems, and mood changes)
- Aches and pains
- Fever
- General malaise
- Chronic fatigue
- Bloody noses

Requirements of Mold Growth

- A food source –such as leaves, wood, paper or dirt
- A source of moisture
- An optimal location (warm stagnant air)

Sources of Indoor Moisture

- Slab foundations
- Flooding
- Backed-up sewers
- Leaky roofs
- Humidifiers
- Damp basement or crawl spaces
- Construction defects
- Plumbing leaks
- House plants- watering can generate large amounts of moisture
- Steam from cooking
- Shower/bath steam and leaks
- Wet clothes on indoor drying lines
- Clothes dryer vented indoors
- Combustion appliances (e.g. stoves) not exhausted to the outdoor

Characteristics of Commonly Encountered Fungi

Alternaria

Specimens of Alternaria are often found growing on carpets, textiles and horizontal surfaces such as window frames. It is commonly found in soil, seeds and plants. It is know to be a common allergen and is associated with hypersensitive pneumonia. Because of its small spore size, it is capable of being deposited in the nose, mouth and upper respiratory system. Sores in the nose, injured skin, and nail infections are prime targets and are easily irritated by Alternaria. It appears as a velvety tuft with long soft hairs and is often confused with Ulocladium as its color ranges from dark olive green to brown. Alternaria is a dry spore and is readily found in air samples as well as on tape lift samples.

Aspergillus

This genera is found on many different textiles and organic materials such as soil, compost, stored grain, wood and paper and its moisture requirements vary widely with some preferring dryer conditions. It is often found in water-damaged carpet. It is a dry spore and spores may be carried in the air making Aspergillus a common cause of respiratory irritation and infection. The mold may be woolly or cottony in texture and shades of green, brown or black in color. The spores are similar to *Penicillium* spores and sometimes indistinguishable though non-viable analysis, and as such, are often classified as Penicillium/Aspergillus.

Chaetomium

This fungus is an allergenic mold genus. Although it is not well documented it is known to cause hay fever and other common allergy symptoms and is sometimes associated with nail infections. It thrives on cellulose containing materials such as paper and plant compost. It is quite commonly found on wet sheetrock paper. It grows very quickly and may be cottony in appearance. It will range in color from white to gray, to olive green and olive brown to black. It has small brown oblong shaped spores that are easily spread by wind, insects and water splash.

Cladosporium

It is the most common mold found in outdoor environments. It is also found indoors on the surface of fiberglass duct liners and interior of supply ducts as well as on dead plants. It is drawn to food, straw, soil, paint, wood, textiles, and grows well on moist windowsills. Cladosporium grows at 0° C so it commonly associated with refrigerator foods. It is a common cause of hay fever, asthma and is a known allergen. It has a distinctive appearance and yields an olive brown pigmentation. The spores

are dry and easily become airborne if disturbed. The mold is moderately fast growing, and may look velvety or woolly.

Fusarium

This mold is found in soil, and on many plants. It requires very wet conditions to grow and is often found in humidifiers. It is know to produce trichothecene toxins, which effect the circulatory, alimentary, skin and nervous systems. On grains, it produces vomitoxin, which can affect you through ingestion and inhalation. Exposure to Fusarium can lead to hemorrhagic syndrome (symptoms include nausea, vomiting, dermatitis, and extensive internal bleeding). Fusarium is allergenic and is often associated with eye, skin and nail infections, and readily infects burn victims. Colonies of Fusarium appear in shades of pink, orange and purple, tan, yellow, and red. It is a wet spore so it does not generally appear in air samples.

Penicillium

This mold is commonly found in air samples as well as in soil, food, grains, paint, compost piles, wallpaper and interior fiberglass duct insulation. It is often found in water-damaged carpets. It can produce mycotoxins, which are allergenic and infect the skin. This soft mold is most commonly found in shades of blue, green and white, and may be velvety, woolly or cottony. Worldwide it is one of the most commonly found fungal genera and is accompanies by a heavy must odor. Identification to the species level can be difficult and the spores are very similar to *Aspergillus* species. See *Aspergillus* above.

Stachybotrys

Is found in building materials with high cellulose content. It is found indoors and grows well in damp straw, wicker and other wood or paper products. It is not known to compete well with other molds, but if there is a high level and constant availability to water for an extended period of time it may become the dominant mold. It is not very common outdoors and is usually not found in outdoor air samples. It has not, until recently, been extensively studied, but is believed to have caused bleeding in the lungs of several children in Cleveland, Ohio. Exposure to Stachybotrys can be particularly hazardous and is reported to produce flu-like symptoms including sore throat, diarrhea, and vomiting. In some cases it is reported to cause hair loss and dermatitis. Stachybotrys appears distinctively from other molds and is a dark gray to black color, sometimes with green, and is shiny when wet. It is a wet spore and does not generally become airborne unless it is disturbed.

Ulocladium

This mold is found on gypsum board, tapestries, wood and other organic materials. It is a potential allergen and produces symptoms such as hay fever and asthma. It is a dry spore and is detected by air samples as well as tape samples. Ulocladium has an appearance similar to Alternaria but tends to appear more brownish whereas Alternaria more often appears as a dark olive green color. Colonies grow rapidly and have a texture similar to velvet.

Mold Inspections

An investigation for mold growth begins with an inspection for visible mold growth. If there is no visible mold immediately noticeable, an inspection for signs of water damage is completed and areas with possible moisture sources are inspected. In general, mold requires a source of moisture to grow.

An obvious source of moisture is the bathroom. Mold growth in bathtubs, showers, and toilets is common and can usually be taken care of through regular housekeeping and maintenance. Similarly, light mold growth is often found on windowsills near the glass, where water condenses. This too can often be taken care of through regular housekeeping, and is usually not a problem unless the mold covers a large surface area or is allowed to grow unchecked such that it becomes

established deep in the wood fibers of the sill. Mold growth on windowsills is often a species of *Cladosporium,* which grows very quickly and is very common outdoors. This mold is usually not hazardous to healthy individuals unless it is present at high levels indoors. If mold growth around windows becomes a problem or a nuisance, installation of double paned windows or a ceiling fan may help to reduce condensation on the glass surface, there by limiting mold growth.

Mold growth over a large area on the windowsill or on sheet rock next to or below the windowsill is a more serious problem, as these surfaces are more likely to support the more hazardous molds, like *Stachybotrys*. Growth under or next to a windowsill may be the result of a construction defect or a flashing problem allowing water intrusion around the window. If water is allowed to intrude into a wall space, the paper backing on the sheet rock (a food source for molds) and the dark, stagnant air spaces create a perfect environment for mold growth to occur. If mold growth is visible on sheet rock inside a room, there may be a larger colony of mold growing on the other side of the sheet rock inside the wall space. If mold growth is suspected inside a wall space, drilling a small hole through the wall can collect an in-wall air sample.

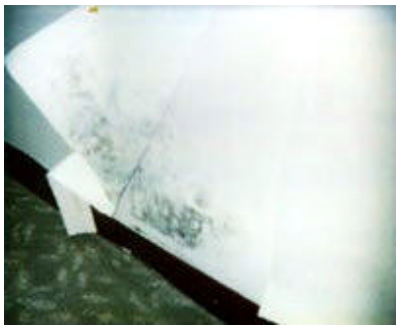
Other possible sources of moisture include:

- Sinks
- Dishwashers
- Leaking roofs and pipes
- Steam from cooking or showers
- Moisture vapor through slab foundations
- Indoor plants
- Wet towels or laundry
- Fish tanks
- Water heaters
- HVAC systems
- Washing machines

Moisture can also intrude into a home through exterior walls as the result of:

- Improper grading of the yard
- Flower beds next to exterior walls
- Outside sprinklers spraying against the house
- Cracked stucco
- Clogged weep screeds
- Missing or torn moisture paper
- *Or a combination of many of these problems*

Areas associated with these moisture sources should be inspected for signs of mold growth or water damage. These signs include:



- Cracked or bubbling paint
- Staining or discoloration
- Damp or soft walls or surfaces
- Buckling or warped flooring of baseboards
- Musty odors

Moisture from slab foundations can be a problem that leads to mold growth under flooring. Some moisture vapor emission from slab foundations is normal and unavoidable and the flooring industry standard for acceptable moisture emission is 3lbs of water per 1,000 square feet per day.

Sometimes the construction of the slab, the soil conditions under the slab, or the amount of time that there was allowed to cure before the house was built can lead to increased amounts of moisture vapor emitted through the foundation. This is not an obvious source of moisture and it often goes undetected for many years. The excess moisture vapor can be widespread, mold growth in carpeting or under tile of linoleum. The mold growth is often not visible, even if the underside of the flooring is inspected, but it does lead to highly elevated levels of airborne molds.

Typically excess moisture is only detected when it starts to cause discoloration of bubbling under linoleum. Sometimes, the signs of excess moisture vapor can be observed by white deposits, or dust, on the bare cement when carpeting is pulled back. These are minerals that precipitate out of the water vapor. Any dark sections of concrete are also signs of moisture. Any discoloration resembling mold growth on the edges of the bottom of the carpet tack strips can also indicate slab moisture problems.

If a slab foundation shows signs of excess moisture, a simple test can be completed to determine just how much moisture is being emitted.

The moisture vapor emission rate (MVER) test uses a canister with calcium chloride crystals that absorb moisture vapor and a plastic "dome" that is placed over the canister and sealed to the cement to create a controlled environment. The test runs for a period between 60 and 72 hours. The canister is weighed before and after the test and the change in weight is used to calculate the MVER.

The comparison of relative humidity and temperature readings inside and outside the building can also be helpful in the evaluation of mold problems inside buildings. Relative humidity levels higher than 60% indoors can foster mold growth as well as other air quality problems such as the growth of dust mites. If the relative humidity is much higher indoors than outdoors, it may be an indication that too much moisture is being trapped inside the building. The home may have a problem with mold or will likely have a mold problem in the future if the moisture is not resolved.

If a mold problem is suspected, because building occupants are experiencing mold related health symptoms or detect musty odors, a client interview may also help to locate the source of mold. Questions to include background information on the building, whether there has been any water damage in the past (even if it was supposedly fixed), when and where health symptoms or odors are most pronounced, and information of building use such as housekeeping activities and ventilation with outside air. A typical inspection checklist can be used as a guide when completing a mold inspection/investigation.

If mold growth is encountered during an inspection, it is important to determine what the specific moisture source is. Even if the mold is abated, it will return if the moisture problem is not resolved. Even a light amount of mold growth on sheet rock can be an indication of a roof or pipe leak or moisture intrusion from the outside. While the visible mold may not seem significant, there may be a larger problem inside the wall space.

A properly constructed and maintained building that has not experienced any water damage should generally not have a problem with mold growth, so if mold is present, a closer look should be taken at the structural issues related to the building.

Mold Sampling And Analysis

There are three basic methods of mold sampling: **air sampling, surface sampling,** and **dust sampling.**

Air Sampling

Air sampling involves drawing a known volume of air over a slide or petri dish with a growth medium. Air sampling can be one of the most effective ways to sample for the presence of mold because it provides quantitative data that can be used to evaluate exposure. It is a measure of the number of mold spores present in the air and an indication of the level of mold spores that is being inhaled in to the lungs. Air sample results are given as either a colony forming units of spores per cubic meter. Air sampling can often detect hidden mold problems, such as growth in carpeting, HVAC systems or inside wall spaces. Air sampling will generally report more species of molds than surface sampling. Surface samples often report between one and four species of molds on each sample, depending on the type of mold growth. Air sample results will detect as many as 30 different types of molds. Whereas a surface sample may miss some species of molds growing over a large surface, these molds will usually show up as elevated in an air sample, as any visible mold growth will usually release spores into the air. Air samples can also be collected from inside wall spaces without any destruction to the wall surfaces.

Air sampling is more expensive due to the equipment required to sample and the higher cost for laboratory analysis. Air sampling may also miss some molds, like the *Stachybotrys* mold, if the spores are not airborne. *Stachybotrys* has “sticky” spores that often do not become airborne unless they are disturbed, which can sometimes lead to false negatives in air samples.

The interpretation of air sampling data can sometimes be difficult. Evaluation of air sample data is based on a comparison of indoor levels to outdoor levels, so an outdoor air sample is always taken whenever an indoor air sample is collected. Generally, indoor spore levels should be 30-80% those of outdoor levels and the distribution of spore types should be similar. Outdoor levels, though, can fluctuate greatly based on many factors including the time of the day, weather conditions, the level of organic debris outside, and the time of year. Wind and rain will increase the levels of some molds and lower the levels of other molds. Organic debris, such as dead leaves or grass are a food source for mold so lawn maintenance will affect the outdoor mold levels. This often leads to higher levels of outdoor molds in the fall.

The degree to which indoor levels correspond to outdoor levels depends on a variety of factors as well, the most important of which is the amount of ventilation with outdoor air that a building has. While outdoor levels change throughout the day, the indoor levels may experience a lag in a corresponding change if the building is not ventilated to the outside. Housekeeping activities will also affect

indoor levels. Mold spores are a natural component of dust. Vacuuming without a HEPA air filter can temporarily cause mold levels to increase.

Dusting with a feather duster can also increase spore levels, while regular dusting with a damp cloth may help reduce mold levels. The level of activity indoors will also affect indoor levels as high activity can disturb settled spores. Air samples are a “snap shot” of the conditions at a given moment and are used as indicators for potential exposure.

Surface Sampling

Surface sampling can be used to determine what kind of mold growth, if any, is growing on a surface. Surface sampling is relatively simple and inexpensive and is effective in identifying the species or genus of *visible* mold growth. Surface sampling will determine the relative density of each of the mold species present on the surface rated of 1+ to 4+ with 4+ denoting the highest number of mold spores. This data can often be misleading without information on the sampling location and the surface area covered by the mold growth. A square foot area on a wall with 2+ levels of a mold species is much more serious than a dime size area with a 4+ level. One of the disadvantages of surface sampling is that it is a check of one particular area. Often if mold growth covers a large surface area, several different types of molds are present and different species are predominant in different areas. It may be necessary to collect multiple samples from several locations to identify all the molds present, especially if trying to determine if *Stachybotrys* is present. Surface sampling also does not provide any information on exposure to airborne spores.

There are three basic methods of surface sampling: bulk sampling, swab sampling, and tape sampling.

Bulk sampling involves the collection of a piece of material that may have mold growth on it. This material can be a piece of sheet rock, carpet, wood, wall paper, cloth, paper, soil, or any other material that is easily collected. Bulk sampling is generally best, as it will allow the lab technician to see the full growth structures of the molds and to look at a larger surface area, which may reveal the presence of multiple species of mold.

Swab sampling involves the use of a sterile swab sample that is misted with water and then moved across the surface of any *visible* mold growth. The swab is then placed in a sterile test tube and submitted for laboratory analysis. For mold growth over a large area, the swab is typically moved in a Z-pattern over a 1 square inch area.

Tape sampling is a very simple method of sampling for molds. To collect a tape sample, you simply place a piece of clear tape on a surface and press down to coat the tape. The tape is then placed on a microscopic slide or is folded over itself. If you are not wearing gloves, you will need to use a paper towel or cloth to press down on the tape to avoid betting fingerprints on the tape.

Dust Sampling

Dust sampling is a relatively new sampling technique that is believed to be a way to evaluate long-term levels of airborne mold spores. Airborne mold spores settle and become a natural part of dust.

Dust sampling involves the collection of dust using a modified vacuum to vacuum a section of carpet or from the air intake filter for the HVAC system. The dust is weighed at the laboratory and then plated onto a growth medium to culture the mold.

This technique is still being evaluated for its effectiveness in determining long-term airborne mold levels. One problem with this technique is that there is no way to correspondingly measure the outdoor mold levels to use for comparison. Another drawback is that the samples can only be analyzed using viable analysis methods, which is discussed in the next section.

In general, sampling using a combination of different sampling methods is the best way to investigate a potential mold problem inside a building.

Sample Analysis

There are two techniques for analyzing mold samples: **viable (culture)** and **non-viable direct exam)**. With viable analyses collected mold specimens are placed on different growth media in petri dishes and after a growth period of 7-14 days, the molds that develop are examined and identified. With non-viable analyses, the mold specimens are examined under a microscope and are identified based on the visual characteristics of the collected spores or specimens. It does not determine weather the mold is viable or non-viable. Both air and surface equipment is used for collecting air samples, depending on whether viable or non-viable techniques. Different kinds of equipment are used for collecting air samples, depending on whether viable or non-viable analysis is needed. Dust samples can only be analyzed using viable methods.

Viable analysis report results as colony forming units of mold species. Air sample data are reported as colony forming units (CFUs) per cubic meter or other volume of air. If a surface sample is collected over a known area, then the culture results will be reported in CFUs per unit of area. Dust sample results are reported as CFUs per gram of dust.

Direct examination of surface samples only reports the relative densities of the molds present on a scale of +1 to +4 with +4 denoting the highest density. Non-viable analysis reports the number of individual spores detected in an air sample, and the results are reported as spores per cubic meter. Sometimes spores are found in clumps, and with direct exam spores in these clumps are counted individually. With culturable methods, a clump of many spores will only develop into one colony-forming unit.

Like the different sampling methods, the different methods for sample analysis have advantages and disadvantages. Direct examination will identify any airborne molds present in the sample, regardless of whether they are viable or non-viable.

This is important because the mycotoxins present on the mold spores can still be harmful even if the spores are dead. Also, some molds, like the *Stachybotrys* mold, can become dormant under certain conditions, such as when exposed to light. These dormant spores are no longer actively growing and reproducing, but are not dead. They will not grow in a viable culture, but may grow again later inside the building where the sample was collected when conditions become favorable again. *Stachybotrys* is thus rarely detected in viable air samples. Direct examinations can also be completed by the lab immediately upon receipt of samples so results can be obtained as soon as the day of sampling if rush service is needed, whereas viable sampling can take up to two weeks.

One problem with direct examination of air and surface samples is that it can be difficult to identify some mold species, and often identification is only possible down to the genus level. Two of the most common molds, the *Aspergillus* and *Penicillium* genera, are indistinguishable using non-viable analysis methods, so they are often grouped together on direct examination reports as spores typical of *Penicillium/Aspergillus*.

Viable cultures can also over represent or under represent some mold species or miss some altogether, depending on the growth media used and other factors such as competition. Some molds will compete better and reproduce in some media, which can make it appear that the airborne levels are higher than they really are. Usually, viable samples are cultured with different types of media to try to reduce this error. Viable analysis also takes longer than direct examination since the lab must wait for the molds to grow before identifying them.

One benefit to viable analysis is that it can differentiate the *Penicillium* and *Aspergillus* molds and identify the different *Aspergillus* species. This is important because the different *Aspergillus* species can produce different mycotoxins, which can

cause different health problems. One species, *Aspergillus* versicolor, produces a mycotoxin called Sterigmatocystin, which is a carcinogen.

Like the different sampling methods, it is generally best to use a combination of analysis methods to fully define a mold problem in a building. If a sampling budget limits the amount of samples that can be collected, though, it is generally better to use non-viable analysis on the samples, so as not to miss any marker genera, like *Stachybotrys*.

Mold Abatement

The first step in mold abatement is to find and eliminate the source of mold. The mold-impacted materials including flooring, sheet rock, insulation, and any other materials with visible mold must be removed and disposed of. It is always safer to remove all the infected material than to try to treat and risk the mold returning, especially if mold is growing on porous materials like sheet rock or wood. For substantial mold growth, this may require removing interior walls and/or siding to expose the framing as shown in the photo.

Any surface that is not easily removed, like wood framing, may remain provided it is not severely impacted with mold growth, is structurally sound, and is thoroughly treated to kill the mold and remove the dead spores. In many cases this may require a 10% chlorine solution with several applications. (Ordinary household bleach is usually a 0.5% chlorine solution) Chlorine at this strength is very caustic to the skin and procedures hazardous fumes and should be used only by a certified and experienced hazardous materials abatement team.

The abatement work depends on the types of molds present. *Stachybotrys* can be especially difficult to eradicate and sometimes require more extensive treatments. With other molds, once the source is removed and the surfaces treated, it is acceptable to still have background levels of spores in the indoor air since these molds are very common outdoors and indoors. *Stachybotrys* is not normally found outside and should not be present in indoor air samples at all. The spores are also sticky so they will stick to furniture and can become dormant, but germinate later if conditions are favorable. Thus, when conducting mold abatement with *Stachybotrys,* it is necessary to fully remove all of the airborne spores as well as the physical growth from the building. This requires additional air filtering and air exchanges during abatement.

When conducting abatement it is necessary to limit the amount of spores that become airborne and prevent cross contamination of spores to clean rooms. This involves sealing off affected areas with plastic, sealing off and/or limiting use of the HVAC system, and using vacuums and air filtering devices with HEPA filters.

Abatement zones should be kept under a negative pressure with engineered controls. Personal protective equipment (PPE) should be used and all personnel should go through decontamination. After the abatement is completed, it is also a good idea to have the HVAC system fully cleaned.

Mold abatement can be extremely hazardous if proper precautions are not taken. Mold spores are found on the surface of mold and become airborne when disturbed. During abatement or cleanup activities mold levels will increase from 10 to 10,000 background levels. It is very important that PPE be worn when doing any kind of mold cleanup. At the very minimum, gloves, goggles, and a dust mask should be worn. Personnel trained in the proper handling of hazardous materials should complete mold abatement of large areas of mold growth. For these jobs, level C PPE is required which includes gloves, full coveralls, and a full-face respirator, as shown in picture to the right.

It is very important that all moisture intrusion issues be resolved after the abatement is completed. The mold will return if all moisture sources are not eliminated!

Confirmation testing should also be completed after the abatement work is completed to verify the success of the abatement work. Samples should include viable surface samples of treated surfaces and air samples in all treated areas. If mold growth is reported from any viable surface samples, additional treatment is necessary. If airborne levels are higher than background levels for any mold species, additional treatment of the surfaces and/or air may be necessary.

Common Misconceptions About Mold

1. **This isn't mold, its just mildew. *Or* this mold isn't the toxic mold.**

   Mold and mildew is the same thing. Mildew is often the term used for mold growth on clothing or fabric. Clothing and fabric

can have a high organic content making them great food sources for mold. The term toxic mold has most often been applied to the *Stachybotrys* mold and can be misleading. While the *Stachybotrys* mold has the potential to be hazardous, there are many other species of mold like *Aspergillus, Penicillium, Fusarium,* and *Alternaria* that are very common and can be just as hazardous. Any mold growth on a surface with an organic content (i.e. paper, cloth, wood, sheet rock, etc) has the potential to be *Stachybotrys* or one of these molds know to have potential negative health effects.

There are even more types of molds that have the potential to cause health problems if present at high enough levels. Any significant amounts of visible mold will likely cause elevated levels of mold spores in the air. Just because mold is not *Stachybotrys*, it does not mean that the mold is not a problem and that it cannot be harmful. Immediate steps should be taken to eliminate any mold growth indoors, regardless of the type, and care should be taken in completing the mold abatement.

2. If the mold is not *Stachybotrys,* it is safe to clean it myself.

When doing any kind of mold abatement, it is necessary to take steps to limit exposure, no matter what type of mold it is. This includes wearing gloves, coveralls, and respiratory protection. Mold levels can increase up to *10 to 100,000* times background levels during mold clean up resulting in acute exposure. For large areas of mold it is recommended that individuals properly trained in the handling of hazardous materials complete the clean up. It is also important to ensure that all infected materials are properly treated or removed so the mold does not return.

3. If you have *Stachybotrys* in your home you have to get rid of all your personal belongings.

When *Stachybotrys* is present there is a risk of cross contamination of spores to clean areas because the *Stachybotrys* spores are sticky and may stick to the surfaces of furniture and other belongings. If *Stachybotrys* contamination is extensive in a home it may be safer and more cost effective to throw away the personal belongings rather than treat them and risk bringing the mold spores into a new residence.

If *Stachybotrys* is growing on wall or other surfaces in a home, it can release spores into the air that will settle on the *surface* of furniture and other belongings. As long as there is no moisture on those surfaces the spores will not form active growth. Since the spores are primarily just on the surface of the furniture, they can be treated and removed.

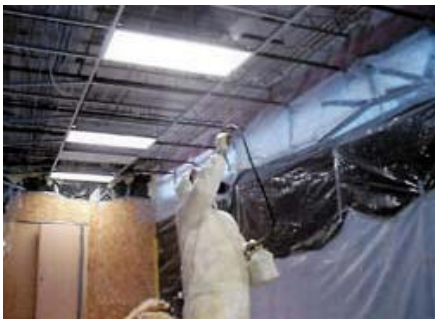
Soft furniture items may require additional cleaning to remove spores. Furniture can also be tested to determine if they contain *Stachybotrys* spores prior to moving into a new home.

4. I want to make sure that my house is free of mold.

No house is completely free of mold. Molds are very common outside, so some mold spores will always be present in the air indoors as well. We are exposed to the outdoor or background levels of molds every time we go outside, and in most cases will not experience any adverse reactions, with the exception of hay fever or allergy like symptoms in some sensitive individuals when outdoor levels are high. Mold *growth* inside a building is *not* normal, though. If mold is growing on a surface inside a home, it will create indoor levels of spores that are higher than what the body is normally used to, which can overwhelm our natural defenses to mold spores and cause adverse reactions. When a home is tested for mold, it is checked to make sure that the levels of molds indoors is comparative to the background levels, and that mold is not actively growing inside.

5. I cleaned the mold with bleach, so I have fixed the problem.

Bleach is not always effective at killing mold, especially if the mold is present on a porous or fibrous material, like wood or sheet rock. If mold growth is significant, it is better to remove the impacted material, rather than treat it. For some surfaces that are harder to remove, like wood framing in homes, it may be necessary to complete multiple treatments with a stronger chlorine solution than is found in bleach.



Cleaning the mold also does not fix the underlying moisture problem that is allowing the mold to grow. Mold should not grow without a moisture source, so if mold is growing on a wall, there may be a hidden leak somewhere or there may be a problem with water intrusion from outside. If mold is growing on sheet rock, there are may be a larger, hidden problem inside the wall space, which is not accessible without removing the sheet rock.

Ten Things You Should Know About Mold

1. Exposure to elevated levels of molds can cause serious health problems, such as respiratory problems and sinus problems, cold and flu-like symptoms, headaches, fatigue, trouble concentrating, and memory loss. Those most susceptible include young children, the elderly, those with

compromised immune systems, and other sensitive individuals.

2. There are many molds that have the potential to cause health problems including *Alternaria, Aspergillus, Chaetomium, Cladosporium, Fusarium, Penicillium,* and *Stachybotrys.* (Just because you can't pronounce it doesn't mean it can't harm you.)
3. Mold spores can cause health problems even if the spores are dead.
4. Mold requires an organic food source, such as cloth, sheet rock, or wood, and a moisture source to grow. Mold can begin to grow if any organic material that remains wet for more than 48 hours. The way to control mold growth indoors is to control moisture indoors.
5. Mold spores are very common outdoors and there is no practical way to eliminate all mold spores indoors.
6. Molds can grow undetected inside wall spaces, under carpet, and inside HVAC systems.
7. Mold growth can often be the visible sign of a structural defect that allows moisture to intrude into a building.
8. When doing mold abatement, it is first necessary to find and eliminate the moisture source. If the moisture problem is not resolved, the mold growth will return.
9. Cleanup of large areas of mold growth can cause airborne levels of spores to increase up to 10,000 times that of background levels resulting in acute exposure to those doing the cleanup if personal protective equipment is not worn.
10. The best way to abate mold growth indoors is to remove the impacted materials. Cleaning the surface of a material with mold growth may not always kill the mold, especially if mold is growing on porous materials like sheet rock or wood.

Frequently Asked Questions About Mold

Q. What are molds?

With more than 100,000 species in the world, it is no wonder molds can be found everywhere. Neither animal nor plant, molds are microscopic organisms that produce enzymes to digest organic matter and spores to reproduce. These organisms are part of the fungi kingdom, a realm shared with mushrooms, yeast, and mildews. In nature, mold plays a key role in the decomposition of leaves, wood, and other plant debris. Without mold, we would find ourselves wading neck-deep in dead plant matter. And we wouldn't have great foods and medicines, such as cheese and penicillin. However, problems arise when mold starts digesting organic materials we don't want them to, like our homes.

Q. How do molds grow in my home?

Once mold spores settle in your home, they need moisture to begin growing and digesting whatever they are growing on. There are molds that can grow on wood, ceiling tiles, wallpaper, paints, carpet, sheet rock, and insulation. When excess moisture or water builds up in your home from say, a leaky roof, high humidity, or flooding, conditions are often ideal for molds. Longstanding moisture or high humidity conditions and mold growth go together. Realistically, there is no way to rid all mold and mold spores from your home; the way to control mold growth is to control moisture.

Q. How can I be exposed to mold?

When molds are disturbed, their spores may be released into the air. You then can be exposed to the spores through the air you breathe. Also, if you directly handle moldy materials, you can be exposed to mold and mold spores through contact with your skin. Eating moldy foods or hand-to-mouth contact after handling moldy materials is yet another way you may be exposed.

Q. How can molds affect my health?

Generally, the majority of common molds are not a concern to someone who is healthy. However if you have allergies or asthma, you may be sensitive to molds. You may experience skin rash, running nose, eye irritation, cough, congestion, and aggravation of asthma. Also if you have an immune suppression or underlying lung disease, you may be at increased risk for infections from molds.

When necessary, some resourceful molds produce toxins in defense against other molds and bacteria called mycotoxins. Depending on exposure level, these mycotoxins may cause toxic effects in people, also. Fatigue, nausea, headaches, and

respiratory and eye irritation are some symptoms that may be experienced from exposure to mycotoxins. If you or your family members have health problems that you suspect are caused by exposure to mold, you should consult with your physician.

Q. How do I know if I have a mold problem?

You may have seen white thread-like growths or clusters of small black specks along your damp bathroom or basement walls, or smelled a "musty" odor. Seeing and smelling mold is a good indication that you have a mold problem. However, you cannot always rely upon your senses to locate molds. Hidden mold can be growing behind wall coverings or ceiling tiles.

Common places to find mold are in areas where water has damaged building materials and furnishings perhaps from flooding or plumping leaks. Mold can also be found growing along walls where warm moist air condenses on cooler wall surfaces, such as inside cold exterior walls, behind dressers, headboards, and in closets where articles are stored against walls. Rooms with both high water usage and humidity, such as kitchens, bathrooms, laundry rooms, and basements are often havens for mold. If you notice mold or know of water-damaged areas in your home, it is time to take action to control its growth.

Q. How can I control mold growth in my home?

Fix any moisture problems in your home:

- Stop all water leaks first. Repair leaking roofs and plumbing fixtures. Move water away from concrete slabs and basement walls.
- Increase air circulation within your home, especially along the inside of exterior walls, and ventilate with fresh air from outside. Provide warm air to all areas of the home. Move large objects away from the inside of exterior wall just a few inches to provide good air circulation.
- Install and use exhaust fans in bathrooms, kitchens, and laundry rooms.
- Ventilate and insulate attic and crawl spaces. Cover earth floors in crawl spaces with heavy plastic.
- Clean and dry water damaged carpets, clothing, bedding, and upholstered furniture within 24 to 48 hours, or consider removing and replacing damaged furnishings.
- Vacuum and clean your home regularly.

Q. What about cleanup?

The time you are most likely to stir up spores and be exposed is the very time you are trying to clean up your mold problem. That's when you need to be the most careful. First, try to determine the extent of the mold infestation. If the area is small and well defined, clean up can be done by you, as long as you are free of any health symptoms or allergies. However, if the mold problem is extensive, such as between the walls or under the floors, you should leave clean up to a professional.

Large Areas	**1.**	Consider having a professional cleanup the area. To find a professional, check under "Fire and Water Damage Restoration" in your Yellow Pages. If you decide to clean up on your own, follow the guidance below.
	2.	Protect yourself by using goggles, gloves, and breathing protection while working in the area. For large consolidated areas of mold growth, you should use an OSHA (Occupational Safety & Health Administration) approved particle mask.
	3.	Seal off area from the rest of your home. Cover heat registers or ventilation ducts/grills. Open a window before you start to clean up.
	4.	Remove all your furnishings to a neutral area to be cleaned later. Follow cleaning directions below.
	5.	Bag all moldy materials, you will be discarding.
	6.	Scrub all hard surfaces with a solution of ¼ cup bleach to one quart of water. Wait 20 minutes and repeat.
	7.	Rinse all hard surfaces with a mild detergent solution, such as laundry detergent and warm water.
	8.	Give the entire area a good cleaning, vacuum floors, and wash bedding and clothes if exposed.

Small Areas	**1.**	Protect yourself by using goggles, gloves, and breathing protection while working in the area. For small isolated areas of mold growth, a cotton dust mask should do.
	2.	Seal off area from the rest of your home. Cover heat registers or ventilation ducts/grills. Cover all your furniture. Open a window before you start clean up.
	3.	Bag all moldy materials, you will be discarding.
	4.	Scrub all hard surfaces with a solution of ¼ cup bleach to one quart of water. Wait 20 minutes and repeat.
	5.	Rinse all hard surfaces with a mild detergent solution, such as laundry detergent and warm water.
	6.	Give the entire area a good cleaning, vacuum floors, and wash bedding and clothes if exposed.

Clean all furnishings exposed to mold.

Permeable and washable		Such as clothing, bedding, and other washable articles. Simply run through the laundry.
Non-permeable and washable		Such as wood, metal, plastic, glass, and ceramics. Mix a solution of one cap bleach to one quart of water. Bleach may fade colors, so test your beach solution before using. If fine, wipe down your articles.
Permeable but not washable		Such as beds and furniture. If these furnishings are moldy you should consider discarding and replacing them. If you decide it is a keeper, take the furnishing outside. Give it a good vacuuming, and let it air out. When finished, if you do not notice an odor it should be okay. However, watch for any mold growth or health problems.