Mold, Housing and Wood

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Photographs courtesy of Berlin D. Nelson, Ph.D and the American Phytopathological Society, from Stachybotrys chartarum: The Toxic Indoor Mold. APSnet, Feb. 2001.

Introduction

Fungi evolved over 400 million years ago (Sherwood-Pike, 1985) and references to mold in buildings suggest that molds have always been present in human environments. At present there is growing public concern about the potential health effects of mold in homes and structures that has been heightened by media reports and litigation.

There are a host of materials in and around the home that, under proper conditions, can become breeding grounds for mold. Molds can grow on organic materials such as drywall paper, wood panels, lumber and carpet backing. They may grow equally well on inorganic materials such as concrete, glass or plastics that may have nutrients on the surface. In all cases, the presence of moisture is a critical condition for the growth of mold.

Lumber is an organic material. In situations with adequate moisture, mold can become established on wood. However, in all cases involving mold, the underlying problems such as flooding or water leaks affect many materials in the structure, including lumber.

The purpose of this document is to provide information to lumber users regarding the origins of mold growth on wood, types of damage caused by mold and steps that may be taken to prevent, remove and control mold growth. Additionally, this document will also discuss mold-related health concerns associated with mold exposure.

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Why is there concern about mold in homes?

Mold growth in homes has not necessarily increased in recent years, but new court cases involving mold, sensationalistic media coverage and publication of questionable scientific research have increased public awareness of the issue.

Much of the recent concern about mold was aroused after several articles on the subject appeared in scientific journals. One of the most widely publicized articles was written by researchers from the U.S. Centers for Disease Control (CDC) (CDC, 1994, 1997). They reported that in 1993, there were 10 cases of acute ideopathic pulmonary hemorrhage/hemosiderosis (AIPH) in infants, some of whom died, that was thought to be linked to the mold Stachybotrys chartarum (also known as Stachybotrys atra).

This article caused great concern and spurred reactions across the country. However, upon closer examination of the study and its data and conclusions, a CDC expert panel and an outside expert panel both refuted the initial findings. Both panels determined there was no reliable scientific evidence that Stachybotrys caused the health problems in these infants (CDC, 2000a).

While the initial report of the CDC research was widely publicized, the revised findings received little coverage. As a result, there continues to be the misperception that there is scientific proof Stachybotrys chartarum causes serious health problems in infants. In fact, the CDC notes: "At present there is no test that proves an association between Stachybotrys chartarum (Stachybotrys atra) and particular health symptoms."(CDC, 2000b)

In the years since the CDC revised the findings of this study, there has been further research and investigation to determine what adverse human health effects may result from mold exposure in indoor environments. Comprehensive reviews of scientific literature by the Institute of Medicine (IOM, 2004), the American College of Occupational and Environmental Medicine (ACOEM, 2002) and the Texas Medical Association (TMA, 2002) have similarly concluded that an association has not been shown to exist between the presence of mold or other agents in damp indoor spaces and AIPH.

In its extensive analysis, the Institute of Medicine did not conclude that any adverse health outcomes are caused by the presence of mold or other agents in damp indoor environments.

The Institute did find sufficient evidence to conclude that there is an association between certain symptoms (upper respiratory (nasal and throat) tract symptoms, cough, hypersensitivity pneumonitis in susceptible persons, wheeze, and asthma symptoms in sensitized persons) and mold or damp indoor environments, but the Institute makes it clear that "associated with" does not mean "caused by."

The Institute also found that the evidence is not sufficient to show even an association between the presence of mold or other agents in damp indoor environments and any other symptom (symptoms examined included shortness of breath, airflow obstruction, mucous membrane irritation syndrome, chronic obstructive pulmonary disease, inhalation fevers, cancer, skin symptoms, asthma development, gastrointestinal tract problems, fatigue, neuropsychiatric symptoms, lower respiratory illness in otherwise healthy adults, and rheumatologic and other immune disease).

The position from the ACOEM generally agrees with the IOM report in that the health effects from mold in indoor environments are limited, in most instances, to allergic health effects in sensitive persons.

Two other articles have influenced the concern about mold and health problems, specifically in persons who worked in office buildings. These studies claimed to show a causal link between working in the buildings and symptoms such as headache, fatigue and cough, as reported in questionnaires (Johanning, 1996; Hodgson, 1998). The authors of these studies concluded that mycotoxins were the root of the health symptoms. However, when these reports were examined closely, they were found to have many limitations and the data did not support these conclusions (Fung, 1998; Page, 1998; Robbins, 2000).

In addition to the above studies, there are some widely cited anecdotal reports of acute, or sudden, health effects attributed to mycotoxins (toxins produced by molds) after exposure to extremely moldy conditions (Brinton, 1987; Croft, 1986; Di Paolo, 1994; Emanuel, 1975; Malmberg, 1993). There is little information in these reports to relate the health effects to mycotoxins and no measurement of exposure. In all of them, the individuals were likely exposed to high concentrations of mold spores but recovered after they were removed from exposure.

Other symptoms, such as nervous disorders, memory loss and joint pain, are attributed to molds. However, there is no credible evidence in the medical and scientific literature that supports the link between molds and these health problems (ACOEM, 2002; IOM, 2004; Page, 2001; Robbins, 2000).

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What is mold?

Molds are part of the fungi kingdom. Fungi are a diverse group of organisms within a wide range of species that include mushrooms, bracket fungi, molds and mildew. Distinguishing features of fungi are the need to extract their food from the organic materials they grow on and the ability to reproduce by way of minute spores. Fungi are a part of nature's recycling system and play an important role in breaking down materials such as plants, leaves, wood and other natural matter.

Mold is the common name for many types of micro fungi. In order to grow, molds require food, suitable temperature (ideally between 70 and 85 degrees Fahrenheit), oxygen and moisture (Zabel, 1992). When these conditions are met, mold will grow and reproduce by creating spores that are released into the air. Molds are very adaptable and can grow even on damp inorganic materials such as glass, metal, concrete or painted surfaces if a microscopic layer of organic nutrients is available. Such nutrients can be found on household dust and soil particles.

Conservatively, more than 100,000 species of mold exist in the world. At least 1,000 mold species are common in the U.S. (Hawksworth, 1999). It is estimated that molds and other fungi make up some 25 percent of the earth's biomass. Most mold spores land on places unsuitable for growth and eventually die. A select few land on surfaces containing nutrients and where the moisture, oxygen and temperature conditions are right for growth.

Mold and mold spores are everywhere around us and have always been a part of our environment. The air we breathe is a virtual jungle of fungal spores. We routinely encounter mold spores as part of everyday life both indoors and outdoors. Spore levels may vary seasonally, but some spores are always present.

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Why does mold grow on wood?

Wood is a biological material consisting primarily of cellulose, lignin and hemicellulose. These three structural polymers make up 90 to 99 percent of the wood mass and give wood its unique properties that make it an excellent structural material (Panshin, 1980).

Wood also contains a variety of other materials, including sugars, starches, proteins, lipids and fatty acids. These materials are present in the storage tissues of the living tree and are essential for a variety of functions. Even after a tree is harvested, these materials remain in the wood and can provide the initial food source for mold fungi.

Mold fungi are rarely present inside a living tree because the bark provides an excellent barrier against fungal and insect attack. Once the tree is harvested, these protective effects decline and the many spores present in the air can settle on the surface and colonize the wood. Also, the food sources for mold -- the stored sugars, starches and other compounds -- are exposed when logs are processed into lumber.

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What types of molds are found on wood?

Under the proper conditions, wood may be colonized by a variety of fungi (Davidson, 1935; Dowding, 1970; Kaarik, 1980). A recent study at Oregon State University revealed that Douglas fir sapwood was colonized by over 45 species of fungi within six weeks after sawing (Kang, 2000). Most of these fungi are common to many other materials, while a few were specialized and only grow on wood.

Molds and stain fungi are the most rapid colonizers of freshly exposed wood. Both fungi discolor the wood and are almost indistinguishable from each other to the naked eye.

Molds are typically characterized as fungi that discolor the wood surface through production of pigmented spores that can be yellow, green, orange, black and an array of other colors. The discoloration seen with molds is usually confined to the wood surface.

Stain fungi discolor the wood more deeply and are not as easily removed. These fungi may produce some discoloration as they grow on the wood surface, but the primary changes occur as they grow deeper into the wood. Stain fungi darken as they age. This darkening creates what is called "blue stain" in the wood (Zink, 1988). Stained wood can experience minor losses in physical properties, but, like molds, the primary changes are in color and the increased ability to absorb liquids (Lindgren, 1952).

Decay fungi may also grow when wood products are exposed to chronic moisture. Decay fungi attack beyond the surface of the wood into the structural polymers of the fiber, reducing its strength. Decayed wood may be discolored, but spores of the decay fungus are not typically found on the surface. Spores of most species are produced on more complex fruiting structures that can produce billions of spores. Generally, decay fungi invade wood in structures after prolonged exposure to moisture, such as what occurs with plumbing leaks or seeping from outdoor water sources.

Many of the molds and other fungi that grow on wood are found on almost any material containing sugars or starches, including plant leaves, bread and other foods. They can grow on a microscopically thin layer of organic material, even forming on common household dust.

These fungi have evolved to rapidly colonize a substrate and utilize the stored sugars as quickly as possible, but they lack the ability to cause significant effects on the wood structure. The most common effect of mold attack on wood is an increase in permeability, which can lead to an increase in moisture or paint uptake (Lindgren, 1952).

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How are molds identified?

Mycology is the scientific study of fungi. Proper identification of molds requires that the person examining the fungi have extensive professional training in mycology. Although some species produce distinctive structures or colors, it is nearly impossible to identify the fungi present on wood with the naked eye. The identification of fungi from a sample using a microscope can take a few days or several weeks, depending on the species.

Most mold and stain fungi are identified by the spores they produce and the structures on which they are produced. Samples can be taken by smoothing a piece of clear tape on the wood surface, then mounting the tape on a microscope slide. Another approach is to cut small pieces from the wood surface, then place these on a nutrient media. Fungi growing from the wood onto the media are then examined under a microscope for spores and other key identifying features.

It is important to note that finding mold does not provide information about the possible exposure to mold, or the risk of health effects from mold. The airborne mold spore concentration, or possible exposure to mold, cannot be calculated from the types and quantity of molds found on surfaces.

In addition, many homeowners ask to have molds identified to species. In most cases, this is unnecessary and costly. Molds are a moisture indicator and should be dealt with as such. Eliminating the moisture source and cleaning the affected surfaces generally negates the need for identification. So-called “mold test kits” should be used with caution and the results interpreted carefully since sampling accuracy is an important aspect in using these kits.

A visual inspection is usually the most effective method for distinguishing clean and moldy environments. In the absence of visible mold growth, sometimes the air is sampled to estimate the number of airborne mold spores.

Air sampling can be expensive and results are difficult to interpret in terms of what is a “normal” environment and what is the potential for health effects. Air sample results only tell what the airborne levels are at the sampling time, providing only a “snapshot in time” of airborne spores. Results are highly variable, due to the natural variability of the environment and the sampling and analysis methods (Baxter et al., 2005).

In general, normal indoor environments are expected to have mold spore levels similar to or less than outdoors. This is because the outdoor air normally is the dominant source of spores in the indoor air.

The most important limitation of air sampling is that there are no health-based standards for mold exposure levels in indoor air, so there is nothing with which to compare the air sample results; and therefore, no way to determine the potential risk of effects from the amount of airborne mold spores found (Terr, 2004).

Individuals who inspect and test homes for mold should have the appropriate education and experience. A certified industrial hygienist (CIH) with experience in sampling for molds is generally qualified to inspect a home for the presence of visible mold, and to collect samples for mold if necessary and to help with interpretation of the results. Industrial hygienists have training in exposure assessment and methods of controlling exposures to molds and other dusts. They can also provide advice on how to control exposure and contamination during clean up of mold.

The American Board of Industrial Hygiene sets standards for certifying hygienists. These standards require at least a bachelor's degree with a minimum 30 semester hours of science and specific industrial hygiene coursework, a minimum of four years of professional level-1 industrial hygiene experience and successful completion of a comprehensive one-day examination.

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What are "toxic molds"?

Some molds are referred to as "toxic molds" because under certain conditions, they can produce mycotoxins. Mycotoxins are compounds "produced by fungi that are toxic to humans or animals and have economic impact." (Ciegler, 1980). Many common molds can produce mycotoxins. Those that arbitrarily have been cited as "toxic molds" include Stachybotrys chartarum (or atra), and various species of Aspergillus, Fusarium and Penicillium.

Mycotoxins are secondary metabolites. This means that the mold does not need to produce mycotoxins to grow or survive. Mycotoxins are produced only when certain environmental conditions are in place and when produced are found in extremely small quantities on a per-spore basis. Mycotoxins are contained in the spore itself and also may be found in the substrate or material in which the mold is growing (Jarvis, 1986).

The isolation of a mold type that has shown to produce toxins ("toxigenic" species) does not substantiate the presence of mycotoxins (Ren, 1999). For example, known mycotoxin-producing strains of Aspergillus flavus and A. fumigatus were grown on various building and construction materials. No mycotoxins were found in extracts of densely colonized ceiling tiles, wallboard, wallpaper and air filters. These negative results were obtained even with enhanced growth when the indoor construction and finishing materials were supplemented with carbon and nitrogen (Tuomi, 2000).

Mycotoxins are relatively large and heavy molecules (Schiefer, 1990; WHO, 1990). This means they are not volatile and do not evaporate from the mold spore or substrate particle. The musty odor associated with mold comes from volatile compounds generated as the mold reproduces (Pasanen, 1996). These compounds, which are different from the mycotoxins, may be annoying and irritating, but are not mycotoxins and are not highly toxic. The concentration of the volatile organic compounds (VOCs) is usually too low, even in damp and moldy buildings, to cause sensory irritation symptoms such as burning eyes and upper airway irritation (Pasanen, 1998; Korpi, 1999). However, the odor of these compounds may be noticeable at levels well below the concentrations that might result in sensory irritation (Pasanen, 1996; 1998).

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What is Stachybotrys?

Stachybotrys is a mold that grows well on chronically wet cellulose material. Outdoors, Stachybotrys typically grows on and breaks down dead plant material. In research conducted by Oregon State University, none of the 45 different species of fungi that formed on samples of Douglas fir sapwood were Stachybotrys chartarum (Kang, 2000). Stachybotrys chartarum and Stachybotrys atra are two different scientific names for the same mold.

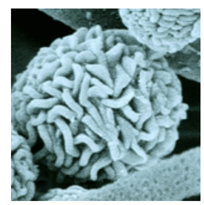

Fig. 1: A conidium of S. chartarum showing the ridged surface of a mature spore. Scanning electron micrograph. Courtesy of Berlin D. Nelson, Ph.D and APSnet

Indoors, it can grow on chronically wet cellulose building materials such as lumber, wood panels, drywall backing, insulation and ceiling tiles. Moisture contributing to indoor growth of Stachybotrys is usually provided by flooding orleaks. Left wet, the spores of Stachybotrys are not easily released to the air. However if allowed to dry, the spores may become airborne and can be inhaled.

The refuted CDC article and other questionable scientific papers directed much attention to Stachybotrys. However, these studies provide nocredible scientific evidence of an association between chronic, low-level Stachybotrys exposure and health effects (Page, 2001). The few reports that associate direct contact and exposures to high concentrations of Stachybotrys with symptoms of skin rash, coughing, chest tightness, bloody nose, fatigue, nausea and—in rare cases—lower white blood cell counts are anecdotal, and are not supported or confirmed by objective scientific data. In these anecdotal stories, symptoms are also reported to cease after the individual is no longer exposed.

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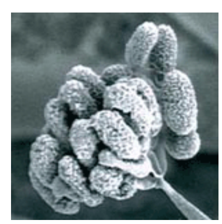

Fig. 2: The mass of conidia of S. chartarum at the tip of the conidiophore. Scanning electron micrograph. Courtesy of Berlin D. Nelson, Ph.D and APSnet

What are the possible health effects of mold?

Humans are exposed constantly to molds in the environment, whether indoors and outdoors. Our immune systems and respiratory clearance systems normally provide defense mechanisms that protect us from health effects of airborne molds. Problems arise when the immune system is suppressed (HIV infection, cancer treatment), over-responsive (allergy) or when exposures are exceedingly high (irritation and mycotoxin effects).

Mold infections are possible in people with immune system supression, but this has not been reported to occur due to mold in residential settings. Some people with compromised immune function, for example people undergoing chemotherapy or organ transplants or people with AIDS, may be at increased risk for opportunistic infections from common molds both indoors and outdoors.

Many people are allergic to molds, and allergic responses include hay fever and asthma. About 5 percent of the American population experience allergic symptoms due to molds and other fungal antigens (fungi other than molds produce spores that may provoke allergic responses) (ACOEM 2002). The most common allergies are to the abundant outdoor molds, such as Cladosporium, Aspergillus and Penicillium. Allergic responses to molds tend to be allergic asthma or hay fever.

Molds can produce volatile organic compounds (VOCs) that can be irritating when present in high concentrations. However, the concentration of the VOCs is usually too low, even in damp and moldy buildings, to cause sensory irritation symptoms such as burning eyes and upper airway irritation (Pasanen, 1998; Korpi, 1999). On the other hand, these VOCs have very low odor thresholds and those odors may be noticed and annoying at levels well below the concentrations that might result in irritation (Pasanen, 1996; 1998).

Routes of exposures to mold include dermal (skin contact), inhalation and ingestion. The route of exposure has a profound effect on the dose, or amount of material or toxin absorbed by the body.

Dermal exposure to mold occurs when the skin is in contact with mold spores. The spores do not pass through the skin, but may cause irritation if there is contact with large amounts of spores or moldy material (Dobrotko, 1945). The irritation may be from reaction to allergenic compounds or chemicals, including mycotoxins, and possibly from rubbing against the spores themselves. Skin is generally a good barrier against particles. Since mycotoxins stay with the particles, the skin is not a significant route of exposure for mycotoxins.

Mold spores or particles that become airborne can be inhaled. Bigger particles are stopped in the upper airways of the nose or mouth, and in the trachea and bronchi. Generally, only the smallest particles -- those smaller than 5 microns -- are able to reach the lungs.

Although mycotoxins can be inhaled, mold spores are small and the amount of toxin in each is tiny. For most people, the airborne concentration needed to get to a toxic dose is in the range of many hundreds of millions of spores per cubic meter of air. (Kelman, 2004)

Ingestion is a more direct exposure route for mold. Historical incidents of mass human poisonings from molds have always involved the eating of moldy foods (Hudler, 1998). Through ingestion, a much larger mass of mold -- and any mycotoxins present -- can be taken into the body as compared to the inhalation route.

Framing lumber in a newly finished house is typically encased by panels or siding on the outside and drywall or panels on the inside. As such, there is virtually no chance for occupants in a home to be exposed to any mold on the wood through skin contact or ingestion.

Inhalation exposure to mold on framing lumber in a finished home is possible, but not very likely. Mycotoxins are not volatile, so they cannot "off-gas" into the environment or migrate through walls or floors independent of a particle. Since particles cannot move through solid objects, mycotoxins in molds contained inside a wall or floor cavity will stay there unless disturbed.

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Where is mold found in buildings?

The presence of molds in our everyday environment means they can grow anyplace under the proper conditions. In all cases, moisture is the essential element for mold growth in buildings.

Mold on lumber

There are many potential sources for unwanted moisture in buildings. For example, improperly maintained air conditioning systems that create excessive condensation can be a breeding ground and distribution mechanism for mold particles.

Mold growth may be found in walls, ceilings and floor cavities when standing water is produced in a building or gets in and stays for more than a few days. Sources for water to support molds and other fungi in homes include plumbing leaks, gaps in roofs, siding or masonry, poorly sealed windows, porous slabs and foundations, inadequate drainage, and faulty roof drains and downspouts.

Poor ventilation and/or air circulation combined with high indoor humidity from showers, cooking or other activities can result in condensation that promotes mold growth on cooler surfaces. Poorly insulated walls may also provide a surface for condensation and mold growth in buildings that do not have general humidity problems.

Surface moisture on unseasoned framing lumber, appearing as the wood dries, may create conditions for mold growth. However, once the moisture content of the wood falls below 20 percent, mold growth can no longer be supported. Depending on the climate, framing lumber will dry to below 20 percent moisture content during the construction and before the building is enclosed.

In instances where wood is chronically exposed to water, wood decay fungi can invade. Decay fungi can penetrate more deeply and attack the structural polymers in the fiber, reducing the strength of the wood.

Other conditions can increase the amount of mold spores in the indoor air of buildings. Homes with exposed-dirt crawl spaces and basements tend to have more airborne mold spores than homes without (Lumpkins, 1973; Su, 1992). With the right humidity conditions, some molds can grow on house dust. It is not surprising, then, that poor housekeeping and high indoor humidity are both associated with increased levels of airborne mold spores (Solomon, 1975; Kozak, 1979).

The biggest source of indoor mold spores is often the outdoor air (Solomon, 1975). Higher levels of indoor mold spores tend to be found in homes with yards having dense and overgrown landscaping (Kozak, 1979).

Indoor mold levels are generally lower in buildings with forced-air heating systems (as opposed to window ventilation) and lower still when these systems include a well-maintained and properly functioning air conditioning system.

Mold spore levels outdoors vary with the season and weather. They may be very high in the growing season or approach zero when snow covers the ground (Solomon, 1975). Except for the snow-cover situation, mold spores in normal indoor environments are usually between 20-50 percent of the outdoor levels.

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Do mold spores move from inside walls or floors into living spaces?

Mold spores may be present in a home but out of sight inside a wall or floor cavity. This mold may have grown during construction and, with the wood dry and moisture gone, be dead or dormant. It may also grow after a leak has been repaired.

There is limited research about whether such "hidden" mold can move into the structure and increase the amount of mold spores in the indoor air. The authors of a recent study, which included analysis of data from 200 homes, concluded that the presence of Stachybotrys inside intact walls is not correlated with Stachybotrys found in the living spaces.

The Wisconsin Department of Health and Family Services investigated the relationship between mold on surfaces of oriented strand board siding and mold levels inside the home. The results of the study indicated mold levels in the affected homes were not significantly higher than those measured in non-exposed homes (Dagger, 1999).

In Veritox's experience sampling many buildings with chronic water leaks and large amounts of enclosed mold (usually more than 10 percent of internal wall area contains mold or wood rot), mold concentrations found indoors are similar to or less than the levels found outdoors. From this it is reasonable to infer that small amounts of mold enclosed in walls, floors, or ceilings will not have a large impact on the indoor air quality.

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How can mold on lumber be prevented?

All fungi have four basic requirements for growth: suitable temperature, oxygen, food and moisture. Eliminating one of these required elements can prevent fungal growth (Scheffer, 1940; 1973).

Mold fungi have fairly broad temperature requirements but most grow best at temperatures between 70 and 85 degrees Fahrenheit. Most fungi require oxygen to function. In fact, one method for preventing stain and mold in wood is to submerge it in fresh water, which fills the wood cells with water and limits the availability of oxygen. Lumber and wood product mills often utilize this method by spraying log decks with water or storing logs in ponds at the plant.

While controlling temperature or oxygen is generally not practical for wood products, it is possible to remove moisture as quickly as possible during manufacturing. Reducing the moisture content of lumber to less than 20 percent will significantly decrease the opportunities for mold to form on the wood.

Drying lumber reduces the likelihood of mold formation. But it does not guarantee the wood will remain free of mold. Lumber that is exposed to moisture after it has been dried will support mold growth.

Dry lumber can become wet through direct sources, such as rainfall or condensation. Even dry lumber contains some moisture. So, wet pieces inside wrapped bundles of lumber could create conditions for mold growth.Exposing the bundle to direct sunlight, for example, could heat the lumber and the wrapping may trap the evaporating moisture. This trapped moisture can be sufficient to support mold growth.

Each year, billions of board feet of lumber are sold as unseasoned, or green products and are allowed to dry naturally, usually during the framing stages of building a house. Many mills reduce the risk of mold and stain on green lumber by applying antistain, or sap stain treatments, which are thin coatings of fungicides on the wood surface. These fungicides are applied by dipping entire bundles of lumber into a treatment solution or by spraying all four surfaces of individual boards (Scheffer, 1940).

These chemicals are designed to provide a microscopic barrier against fungal attack that lasts for three to six months, depending on the chemical, the concentration used, the wood species and the climatic conditions. The chemicals used for preventing mold and stain are usually very mild and include many used on food crops as well as in shampoos and paints. They are not designed for long-term protection of the wood.

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When should mold be removed?

Visible mold growing on surfaces where people may come in contact with it should be cleaned and removed. The decision to remove mold from enclosed cavities must be made after considering how much mold is likely to be present and how likely it is to be opened or disturbed.

In some cases, wood can simply be treated for mold growth with a bleach solution, then dried and sealed. Where mold is present in existing structures, there are often reasons for opening walls and removing building parts that are unrelated to mold growth (such as for repairing warped and water-damaged floors or walls). In buildings where mold removal from enclosed cavities is not desirable or feasible, sampling can be conducted to monitor the level of mold spores in the occupied spaces.

The process of removing mold from enclosed spaces could increase exposure to spores in the short term. High indoor mold spore levels are sometimes found when walls and floors containing mold are opened or disturbed, and when visible mold growth is present on exposed surfaces.

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Can I clean the mold from the wood?

The decision to clean mold from lumber depends on the amount of mold present and how likely it is to be disturbed. In nearly all cases, mold cleaning should be undertaken only after any moisture problems are resolved.

For any mold clean up that may generate large amounts of dust, basic personal protection equipment such as rubber gloves, eye protection and a high-quality pollen or dust mask should be worn. Clean-up of small spots or areas of mold generally does not require any special protective equipment.

There are a number of products on the market, from commercial mildewcides to common bleach, which are promoted for removing mold from wood. However, the U.S. Environmental Protection Agency suggests using mild detergent and water for most mold clean up. For cleaning wood surfaces, the EPA recommends wet vacuuming the area, wiping or scrubbing the mold with detergent and water and, after drying, vacuuming with a high-efficiency particulate air (HEPA) vacuum (EPA, 2001).

The molds seen on lumber are largely a collection of fungal spores on the surface of the wood. As such, wet wiping or scrubbing the lumber will remove the mold.

Simply wiping the wood, however, can release those spores into the surrounding air. A better approach is to gently spray or wet down the mold prior to removal. Once the mold has been wetted, it can be removed by wet-wiping the surfaces with a water and detergent solution, scrubbing if necessary.

If commercial products are used for cleaning mold, be sure to follow the manufacturer's instructions for use. Common bleach also can be used, particularly to clean the discoloration caused by mold fungi. The U.S. Centers for Disease Control (CDC) recommends using a solution of 10 parts water to one part chlorine bleach to clean mold from surfaces (CDC, 2000b). When using bleach and other cleaning chemicals indoors, make sure there is adequate ventilation and wear personal protection equipment outlined previously. Never mix bleach with ammonia.

Removing small amounts of mold from wood is relatively straightforward. Mold removal becomes more complex when there are heavy amounts of growth on a majority of the lumber or if the building has been in service for some time and the mold originated from leaks into the building cavity. In these instances, the mold clean up should be done by a professional cleaning and restoration company.

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Once I clean the mold, can it come back?

Mold spores are present on surfaces in all homes, so cleaning will not prevent re-growth of mold. Even if a building is stripped of all components and every spore is killed or removed, normal background mold spores from outdoors or on replacement parts have the potential to grow (Taylor, 2004).

The most important objective in any mold removal is to remove or repair any sources of moisture. Should the wood framing in a house become wet, through leaks or flooding, it is imperative that the area be dried as soon as possible.

In many climates, this drying will occur naturally once any standing water is removed. In other climates where the relative humidity is higher, it may be necessary to bring in portable fans to increase airflow or to use the existing heating system or portable electric heaters to encourage faster drying.

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Are there mold regulations?

In the U.S., there are currently no regulations or exposure limits for molds or mycotoxins. This is true for homes, occupational settings, schools, stores and other public buildings.

In the occupational setting, the general duty clause may apply to mold exposures. This is the rule that requires employers to provide workers with a safe and healthy work environment. The Occupational Safety and Health Administration (OSHA) should be consulted for specific information on work-related mold questions.

Because there are no exposure limits for molds, there are no "benchmarks" with which to compare exposure measurements. Typically, measured indoor airborne mold levels are compared to outdoor concentrations. Differences between the types and numbers of molds indoors vs. outdoors can provide clues as to whether the exposures indoors are above the background level and whether there is a source of mold inside the building. However, these data usually cannot be used to determine if exposure levels are safe. In most cases, air sampling for mold is not needed to assess or remediate a mold problem.

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Summary

Molds play an important role in nature by breaking down organic materials. We routinely encounter mold spores as part of everyday life, in both outdoor and indoor environments. In most cases, the body's immune and respiratory systems normally provide defense mechanisms that protect it from health effects of regular exposure to molds.

Inhalation of molds can result in a range of health effects in some circumstances. Infections are possible in immune-compromised people, although there are no reports of this occurring from mold growth in a residence. Allergic responses to molds include hay fever and asthma, and many people with allergies are also allergic to mold. The amount of mold that must be inhaled to cause an allergic response is unknown. Toxic effects from inhalation of mold may occur in situations where there is prolonged exposures to exceedingly high airborne mold concentrations, such as in an agricultural setting. These high concentrations have not been reported to occur in residences with mold enclosed in finished walls.

Lumber is just one of thousands of materials that can be a potential growth substrate for mold under the proper conditions. In a vast majority of cases, mold problems in homes are related to flooding or water leaks that affect many materials in the structure, including lumber.

Moisture is essential for mold growth and controlling moisture offers the best protection against mold. While all wood contains moisture, mold growth is not supported on wood dried to below 20 percent moisture content. Lumber used in construction will typically dry to below 20 percent moisture content before the structure is enclosed.

Drying lumber does not guarantee the wood will remain free of mold. If lumber is exposed to moisture after it has dried, it can provide a surface for mold to grow.

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