

RELATIONSHIP OF MOLD TO INDOOR AIR QUALITY
PENELOPE YOUNG
EH 472 AIR QUALITY MANAGEMENT
JUNE 3, 2004

Indoor Air Quality

Indoor air quality is a serious concern because of the amount of time we spend in our homes. Exposures to harmful components can be higher indoors because of sources within the home that emit pollutants. Indoors, the air is trapped without exchange or dilution. In the last decade, efforts at increasing energy efficiency have diminished the amount of airflow within a house. Improvements in sealants, insulations, windows, and cladding have resulted in domiciles that are practically airtight. Pollutants can accumulate and cause health problems that range from minor symptoms, allergic sensitization, to disease, or chronic conditions.

An airtight home also holds in moisture, and prevents evaporation through air exchange. This has led to a recent increase in concern over the presence of different types of molds and mildews. Newer, air tight, energy efficient homes are perfect growth environments for mold.

MOLD MORPHOLOGY

Mold is a ubiquitous member of the Fungus family. It is found planet-wide in all types of environments, on land and in water. It grows in any conditions, from acidic to basic, salty or not, hot or cold. Mold grows best in the presence of sugars, especially cellulose, a component of many building materials. Fungi are the world's strongest decomposers, breaking down an astounding range of organic matter into forms that are more readily usable by plant life. Mold is a filamentous colonizer, which means it grows in large, thin, connected layers. The body of the mold is composed of hyphae, a filamentous tube-like system throughout the growth of the mold. There is no cellular division, and the cytoplasm of the mold is not compartmentalized as it is in higher plants. This is why it has a wet, slimy appearance.

When a mold colony reaches sufficient size, it becomes reproductive, producing stalks that release airborne mold spores. When a mold spore lands on a sufficiently wet surface, it will germinate and begin to divide, growing a new colony. Mold spores are extremely small and remain airborne, and can be transported over long distances. Mold spores can remain dormant for extremely long periods of time. Spores

that inhabit materials and areas that become exposed to water can subsequently germinate and grow if the water source is not eliminated.

HEALTH RISKS OF MOLD

Mold is a health risk to human beings because of the nature of the mold's physical chemistry. Some molds can produce toxins, specifically called Mycotoxins, which are poisonous to human cells, and produce allergic response.

Dr. Stephen C. Redd, Chief of the Air Pollution and Respiratory Health Branch of the National Center for Environmental Health, Centers for Disease Control and Prevention gave a Statement for the Record before the Subcommittees on Oversight and Investigations and Housing and Community Opportunity. This is a subcommittee of the United States House of Representatives. His statement was titled "State of the Science on Mold and Human Health".¹

In his statement, Dr. Redd reported that the CDC has identified two mold toxins, aflatoxins and ochratoxin A, as being carcinogenic. Studies are underway to determine the prevalence and exposures related to these mold toxins. Dr. Redd informed the committee that chronic exposure to mold produces a variety of illnesses, including:

- farmer's lung
- hypersensitivity pneumonitis
- allergic rhinitis
- conjunctivitis
- Allergic asthma.

Effects of Mold on the Immune System

The human immune system is designed to attack and destroy any foreign particles, including toxins, which enter the body. There are two basic types of immune response, the innate and the adaptive.

The innate response automatically deals with any foreign matter, and includes defenses such as the replacement of skin cells, and the action of the muco-ciliary mechanism of the lungs. Innate immune responses also involve cells within the blood that are designed to recognize invaders and engulf them in a process called phagocytosis.

The adaptive immune response is more complicated, and involves the specific recognition of molecules, called antigens. An antigen is a protein, polysaccharide, or large molecule that the immune system targets for elimination. The white blood cells that participate in phagocytosis can recognize antigens and mark them. This signals other

¹ **Redd, Stephen C., M.D.** *State of the Science on Mold and Human Health.* Transcript of Statement for United States House of Representatives. 2002 <http://www.cdc.gov/nceh/airpollution/images/moldsci.pdf>

cells in the blood to make complex proteins called antibodies. The purpose of an antibody is to initiate a cellular chain reaction that will destroy the marked cells. When an antibody attaches to an antigen, phagocytic cells called macrophages are stimulated. At the same time, the blood vessels are stimulated to dilate and become porous, enabling more macrophages and other white blood cells to migrate to the site of the antigens. Fluids are released from the vessels in large amounts, causing the runny nose, sneezing, and inflammation of the immune response.

This adaptive immune response does not occur immediately upon the first encounter with an antigen. In the case of mold, depending on the person's immune makeup, it may take several exposures, or a long period of exposure before the adaptive immune system is triggered, or sensitized to the presence of the mold antigen. After the initial sensitization, the response increases in severity. One plasma cell of the immune system can produce 1000 antibody molecules per minute.² In the case of infection by pathogenic bacteria like *Staphylococcus Aureus*, this could save a person's life. In the case of exposure to mold, it could make a person's life miserable.

Current scientific study is underway on a specific type of mold that is thought to cause significant allergy sensitizations. The culprit is *Stachybotrys chartarum*, also known as black mold. *Stachybotrys* is a type of mold that produces a mycotoxin, which is a molecule that is poisonous to human cells, and a strong antigen. The symptoms that have been reported with *Stachybotrys* exposure are³

- headache,
- eye irritation,
- coughing,
- wheezing,
- sneezing,
- runny nose,
- shortness of breath,
- fatigue
- difficulty breathing.

Some studies have reported a syndrome called "acute idiopathic pulmonary hemorrhage of newborns", but these studies have not been independently verified, and are still under scrutiny. Chronic mold

² **Ingraham, John L. and Catherine.** Introduction to Microbiology. Brooks-Cole/Thomson Learning, 2004. Pacific Grove, CA. pp. 286 - 291.

³ **United States Centers for Disease Control** website. Stachybotryus Mold Facts. <http://www.cdc.gov/nceh/airpollution/mold/stachy.htm>

exposures are also suspected of causing Chronic Obstructive Pulmonary Disease.⁴

Another type of harmful mold is *Aspergillus fumigatus*. This mold also produces a toxin, and its effects on human health are more severe and more fully documented than that of the *Stachybotryus*. The CDC reports that Aspergillosis is a form of invasive pulmonary infection.⁵ Symptoms include chest pain, fever, and cough. It can spread to other vital parts of the body, including the brain, skin and bone. Allergic sinusitis and allergic bronchopulmonary disease are also known to be caused by this organism.

MOLD IDENTIFICATION AND REMEDIATION

Mold identification and remediation has become a science in itself, and a very lucrative business in the United States. It is expected that mold inspections are going to be required in the not too distant future on all new loans issued by the Federal Housing Authority (FHA). The problem with mold remediation is that the process itself can cause the spores to be released. The slimy covering coats the spores, inhibiting their dispersion. When the water source is removed, the mold dries up and the spores are exposed. Removal of the wallboards or surfaces that are molded causes the spores to be disbursed throughout the home, and increases the exposure. In order to properly remove a mold colony from a home, the molded surface should be covered with plastic or sealing paints, and then removed. The piece of wallboard should be wrapped in plastic before being removed from the room it was taken from. Dead mold can still cause allergic reactions, so the mold must not only be killed, but removed as well. Fungus has the ability to decompose paints, so sealing will not be sufficient to prevent regrowth.

MOLD PREVENTION

The best way to deal with mold is to prevent it. Mold requires water to grow, so the first step in mold prevention is to remove the water source. This can be as simple as sealing a basement wall or as complex

⁴ **Redd, Stephen C., M.D.** *State of the Science on Mold and Human Health*. Transcript of Statement for United States House of Representatives. 2002 <http://www.cdc.gov/nceh/airpollution/images/moldsci.pdf>

⁵ **United States Centers for Disease Control** website. *Aspergillus Mold Facts*. http://www.cdc.gov/ncidod/dbmd/diseaseinfo/aspergillosis_t.htm

as resurfacing a yard to eliminate flooding. Some standard mold prevention techniques are:⁶

- Source control
- Ventilation improvements
- Weatherization

In source control, any existing mold should be removed, and the water source eliminated. In the case of shower/bathroom mold, contaminated wallboards, caulk, or ceiling tiles should be replaced. Ventilation ducts should be tested for mold, and if it is present, the duct system should be professionally cleaned.

Ventilation improvements increase evaporation, eliminating condensation moisture that promotes the growth of mold in bathrooms, basements, and on window sills. Improving ventilation can be as simple as opening the windows, or installing a bathroom fan. A dehumidifier reduces water vapor in the air, and discourages mold growth.

Weatherization greatly reduces the incidence of mold by reducing condensation surfaces such as single paned windows. Water vapor in a warmer house will not condense as readily, and eliminate that source of water as a mold growth factor.

The following is a list of recommendations on mold prevention from the official CDC website on mold.⁷

- Keep humidity level in house below 50%.
- Use air conditioner or a dehumidifier during humid months.
- Be sure the home has adequate ventilation, including exhaust fans in kitchen and bathrooms.
- Use mold inhibitors which can be added to paints.
- Clean bathroom with mold-killing products.
- Do not carpet bathrooms.
- Remove and replace flooded carpets.

Immediate attention to water problems is imperative. If a saturated area is dried within 24 to 48 hours of onset, mold will not grow⁸. Untended roof gutters can overflow and direct rain into walls and

⁶ **United States Environmental Protection Agency** Website. "The Inside Story: A Guide to Indoor Air Quality".
<http://www.epa.gov/iaq/pubs/insidest.html>

⁷ **United States Centers for Disease Control and Prevention**. "Questions and Answers on *Stachybotrys chartarum* and other molds".
<http://www.cdc.gov/nceh/asthma/factsheets/molds/default.htm>

⁸

attics. Blocked air-conditioning overflows provide an excellent environment for mold growth.

CONCLUSION

Mold infestation is proven to harm human health. The full extent of the risk is not fully known, and the CDC is currently working on several investigations on various molds and their effects. Fortunately, the methods of remediation are easily understood and fairly simple to apply. Health risk is greatest in the elderly, immuno-compromised, and children. Special precautions should be taken to ensure a mold free environment for these populations.

BIBLIOGRAPHY

California Department of Environmental Health and Safety, Indoor Air Quality Website. “Questions about Mold”. <http://www.cal-iaq.org/mold0107.htm>

California Department of Health Services, Environmental Health Investigations Branch, “*Stachybotrys chartarum*, a mold that may be found in water-damaged homes”. November 2000
http://www.ehib.org/cma/paper.jsp?paper_key=STACHYBOTRYS_2000

Ingraham, John L. and Catherine. Introduction to Microbiology. Brooks-Cole/Thomson Learning, 2004. Pacific Grove, CA. pp. 286 – 291.

Redd, Stephen C., M.D. Chief, Air Pollution and Respiratory Health Branch, National Center for Environmental Health, Centers for Disease Control and Prevention, U.S. Department of Health and Human Services. “*State of the Science on Mold and Human Health*”. Transcript of Statement for the Record Before the Subcommittees on Oversight and Investigations and Housing and Community Opportunity, Committee on Financial Services, United States House of Representatives. 2002
<http://www.cdc.gov/nceh/airpollution/images/moldsci.pdf>

United States Centers for Disease Control and Prevention. “Questions and Answers on *Stachybotrys chartarum* and other molds”.
<http://www.cdc.gov/nceh/airpollution/mold/stachy.htm>

United States Centers for Disease Control website. “*Aspergillus* Mold Facts”.
http://www.cdc.gov/ncidod/dbmd/diseaseinfo/aspergillosis_t.htm

United States Environmental Protection Agency. “A Brief Guide to Mold, Moisture, and Your Home”.
<http://www.epa.gov/iaq/molds/moldguide.html>

United States Environmental Protection Agency Website. “The Inside Story: A Guide to Indoor Air Quality”.
<http://www.epa.gov/iaq/pubs/insidest.html>