

Introduction

Molds are a natural and important part of our environment. They are ubiquitous and are found virtually everywhere. Molds produce tiny spores to reproduce. These spores can be found in both indoor and outdoor air and on indoor and outdoor surfaces. When mold spores land on a damp spot, they may begin growing and digesting whatever they are growing on in order to survive, leading to adverse conditions. In response to increasing public concern, a number of government authorities, including the United States EPA, California Department of Health Services and New York City Department of Health, have developed recommendations and guidelines for assessment and remediation of mold. Websites for these organizations can be found at the end of this report.

While it is generally accepted that molds can be allergenic and can lead to adverse health conditions in susceptible people, unfortunately there are no widely accepted or regulated interpretive standards or numerical guidelines for the interpretation of microbial data. The absence of standards often makes interpretation of microbial data difficult and controversial. This report has been designed to provide some basic interpretive information using certain assumptions and facts that have been extracted from a number of peer reviewed texts, such as the American Conference of Governmental Industrial Hygienists (ACGIH). In the absence of standards, the user must determine the appropriateness and applicability of this report to any given situation. Identification of the presence of a particular fungus in an indoor environment does not necessarily mean that the building occupants are or are not being exposed to antigenic or toxic agents.

None of the information contained herein should be construed as medical advice or a call to action for evacuation or remediation. Only a qualified physician should make any decision relative to medical significance.

EMLab P&K did not conduct the site investigation, provide consulting or collect the samples referenced in this report. EMLab P&K's primary involvement in this project is to provide analytical results for the samples submitted. The data presented in this report are based on the samples and accompanying information provided and represents concentrations at a point in time under the conditions sampled.

EMLab P&K's standard terms and conditions govern all aspects of this report.

Materials

Please refer to the chain of custody included with this report.

Methods

1. Surface Samples – Swab, Dust, Tape and Bulk Samples

Swab, Dust and Tape samples are mounted on a glass slide and observed under a bright field microscope for either Qualitative or Quantitative Examination. A bulk sample is also simultaneously observed under a stereomicroscope to look for signs of any visible discoloration or fungal growth, which is then mounted and observed under a bright field microscope for either Qualitative or Quantitative Examination. The samples are analyzed at a minimum of 200X magnification and up to a 1000X magnification. In the qualitative

examination, the prepared samples are observed for the presence of any structures or skewing of spore distribution that may indicate growth in the sample being analyzed. In the quantitative examination, the mold spores detected in the sample are counted and reported as spores per cm², spores per gram (or 1000mg), or spores per swab/wipe, etc depending on the sample type. These methodologies do not differentiate between viable and non-viable fungal spores.

2. Air Samples- Spore Trap Device

Spore traps are a unique sampling device designed for the rapid collection and analysis of a wide range of airborne particulates, including fungal spores. While analyzing the sample, the analyst takes a number of variables into account to select the proper analytical method to accurately determine the densities of the various spores on the trace. The densities of the debris and the spores on the trace will determine the approach to analyzing the sample. In general, the sample is directly mounted under the microscope and the various airborne particles detected are counted at a minimum of 200X magnification and up to 1000X magnification, with the entire trace (100% of the sample) being analyzed at 200X or 600X. This method does not differentiate between viable and non-viable fungal spores. This technique does not allow for the differentiation between *Aspergillus* and *Penicillium* spores. Additionally, depending on morphology, other non-distinctive spores are reported in categories such as ascospores or basidiospores. All slides are graded with the following debris scale for data qualification.

Debris Rating	Description	Interpretation
None	No particles detected.	No particulates on slide. The absence of particulates could indicate improper sampling as most air samples typically capture some particles.
<1+	Good visibility. A few particles detected.	Reported values are not affected by debris.
1+	Good visibility. No crowding of particles.	
2+	Decent visibility. Particles beginning to crowd.	Non-microbial particulates can mask the presence of fungal spores. As a result, actual values could be higher than the numbers reported. Higher debris ratings increase the probability of this bias.
3+	Decent visibility. Particles beginning to crowd.	
4+	Poor visibility. Particles beginning to overlap.	Excessive debris detected in the sample. Counts reported may vary drastically and actual values could be higher than the numbers reported. The sample should be collected at a shorter time interval, or other measures taken to reduce the collection of non-microbial debris. In addition, a >4+ rating will only allow for a count from the perimeter of the slide.
>4+	Poor visibility. Particles overlapping.	

3. Comments

Comments identify issues or events that are relevant to your analytical results. A comment includes information about any peculiar observation or situation encountered while analyzing the sample. In each case, the comments provide significant information vital to the interpretation of the laboratory data.

4. Data Interpretation

According to ACGIH, "Data from individual sampling episodes is often interpreted with respect to baseline data from other environments or the same environment under anticipated low exposure conditions." In the absence of established acceptable exposure limits, it is often necessary to use a comparison standard when interpreting data. In this instance, it will be necessary to sample the suspect area as well as a non-suspect area.

According to ACGIH, "...active fungal growth in indoor environments is inappropriate and may lead to exposure and adverse health effects."

a. Total Fungal Spores

According to ACGIH, "... differences that can detected with manageable sample sizes are likely to be in 10- fold multiplicative steps (e.g., 100 versus 1000...)". Following this logic, if total fungal spores are ten (10) times greater in the sample from a suspect area than in the negative control sample collected from a non-suspect area, then that sample area may be a fungal amplification site.

b. Mycelial Fragments

Mycelium is a fungal mass that constitutes the vegetative or living body of a fungus. Following the same logic above, if total mycelial fragments are ten (10) times greater in the suspect sample than in the negative control, then the sample area is considered to be a fungal amplification site. The presence of mycelial fragments provides evidence of microbial growth.

c. Mycotoxins

Molds can produce toxic substances called mycotoxins. More than 200 mycotoxins have been identified from common molds, and many more remain to be identified. Some of the molds that are known to produce mycotoxins are commonly found in moisture-damaged buildings. Exposure pathways for mycotoxins can include inhalation, ingestion, or skin contact. Although some mycotoxins are well known to affect humans and have been shown to be responsible for human health effects, for many mycotoxins, little information is available, and in some cases research is ongoing. Some molds can produce several toxins, and some molds produce mycotoxins only under certain environmental conditions. The presence of mold in a building does not necessarily mean that mycotoxins are present or that they are present in large quantities.

d. Water Indicator Molds

Certain authorities identify certain molds whose presence indicates excessive moisture. The presence of a few spores of indicator mold should be interpreted with caution. Additionally, it should be recognized that these named molds are not necessarily the only ones of potential significance.

e. Mold Glossary








Specific characteristics of the individual molds listed in the report are presented in Table 1.






f. Useful Resources

- i. Guidelines on Assessment and Remediation of Fungi in Indoor Environments, New York City Department of Health.
www.ci.nyc.ny.us/html/doh/html/epi/moldrpt1.html
- ii. Facts about Mold, New York City Department of Health.
www.ci.nyc.ny.us/html/doh/html/epi/epimold.html

- iii. Mold Resources, United States Environmental Protection Agency.
<http://www.epa.gov/mold/moldresources.html>
- iv. Mold in My Home, What do I do? California Department of Health Services.
www.asbestos.org/Microbial/index.html

Table 1: Summary of Specific Mold Characteristics

Fungi	Environmental Indicator		Typically Found
<i>Alternaria</i>			<i>Alternaria</i> is one of the more common fungi found in nature. It is found growing indoors on a variety of substrates including wallboards, painted walls, etc.
<i>Arthrimum</i>			<i>Arthrimum</i> is a saprobe and is found on plants. It is rarely found growing indoors.
Ascospores			Ascospores are ubiquitous in nature and are commonly found in the outdoor environment. Some fungi that belong to the ascomycete family include the sexual forms of <i>Penicillium/Aspergillus</i> , <i>Chaetomium</i> , etc that may be frequently found growing on damp substrates.
<i>Aureobasidium</i>			<i>Aureobasidium</i> is commonly found in a variety of soils. Indoors, it is commonly found where moisture accumulates, especially bathrooms, and kitchens, on shower curtains, tile grout, windowsills, textiles, and liquid waste materials.
Basidiospores			Basidiospores are Saprophytes and plant pathogens and are commonly found in gardens, forests, and woodlands. They also include organisms that are the agent of "dry rot," and other fungi that cause white and brown wood rot, which may grow and destroy the structural wood of buildings.
<i>Bipolaris/ Dreschlera</i>			<i>Bipolaris</i> and <i>Dreschlera</i> are usually found associated with plant debris, and soil. They are plant pathogens of numerous plants, particularly grasses. <i>Bipolaris</i> and <i>Dreschlera</i> can grow indoors on a variety of substrates.
<i>Botrytis</i>			<i>Botrytis</i> is commonly found in tropical and temperate climates growing on vegetative matter. They may be found indoors in conjugation with indoor plants, fruits and vegetables.
<i>Chaetomium</i>			<i>Chaetomium</i> is often found on materials containing cellulose such as sheetrock paper, or other wet materials.
<i>Cladosporium</i>			<i>Cladosporium</i> is a common outdoor mold. They are commonly found on dead plants, food, textiles, and a variety of other surfaces. Indoors, they can grow on a variety of substrates including textiles, wood, moist windowsills, etc. It can grow at 0°C and is associated with refrigerated foods.
<i>Curvularia</i>			<i>Curvularia</i> is found on plant materials and is considered a saprobe. Indoors, they can grow on a variety of substrates.
<i>Epicoccum</i>			<i>Epicoccum</i> is a saprophyte and considered a weekly parasitic secondary invader of plants. They tend to colonize continuously damp materials such as damp wallboard and fabrics.
<i>Fusarium</i>			<i>Fusarium</i> requires very wet conditions and is frequently isolated from plants and grains. They colonize continuously damp materials such as damp wallboard and water reservoirs for humidifiers and drip pans.

<i>Memmoniella</i>			<i>Memmoniella</i> can be found growing on a variety of cellulose-containing materials.
<i>Nigrospora</i>			<i>Nigrospora</i> is especially abundant in warm climates and is rarely found growing indoors.
<i>Oidium/Peronospora</i>			<i>Oidium</i> and <i>Peronospora</i> are plant pathogens and are not found growing indoors.
<i>Penicillium/Aspergillus</i>			<i>Penicillium</i> and <i>Aspergillus</i> are ubiquitous in environment. <i>Aspergillus</i> tends to colonize continuously damp materials such as damp wallboard and fabrics. <i>Penicillium</i> is commonly found in house dusts, wallpaper, decaying fabrics, moist clipboards, etc.
<i>Pithomyces/Ulocladium</i>			<i>Pithomyces</i> is commonly found on grass and decaying plant material and are rarely found growing indoors. <i>Ulocladium</i> has a high water requirement and therefore colonizes continuously damp materials such as damp wallboard and fabrics.
Rusts			Rusts are plant pathogens and only grow on host plants.
Smuts/Periconia/Myxomycetes			Smuts and Myxomycetes are parasitic plant pathogens that require a living host. Smuts do not usually grow indoors. <i>Periconia</i> are rarely found growing indoors. Myxomycetes are occasionally found indoors, but rarely growing.
<i>Stachybotrys</i>			<i>Stachybotrys</i> are commonly found indoors on wet materials containing cellulose, such as wallboard, jute, wicker, straw baskets, and other paper materials.
<i>Stemphylium</i>			<i>Stemphylium</i> is either parasitic or saprophytic and is rarely found growing indoors.
<i>Torula</i>			<i>Torula</i> can grow indoors on cellulose containing materials such as wallboard, jute, wicker, straw baskets, and other paper materials.
Other brown/colorless			An uncharacteristic fungal spore that does not lend itself to classification via direct microscopy.



Potential Water Intrusion/Indicator Mold



Potential Water Intrusion/Indicator Mold Capable of Mycotoxin Production

Quality Programs

The EMLab P&K's laboratory network is staffed with highly trained analysts, the majority of which hold advanced degrees. The reliability of test results depends on many factors such as the personnel performing the tests, environmental conditions, selection and validation of test methods, equipment functioning, as well as the sampling, storage and handling of test items, all of which are a reflection of the overall quality system of the laboratory.

EMLab P&K has modeled its quality system after ISO 17025, General Requirements for the Competence of Testing and Calibration Laboratories, one of the most stringent sets of standards in the industry, to ensure that its customers receive the highest standard of accuracy, reliability, and impartiality that they have come to expect from the leader in the environmental industry. EMLab P&K's laboratories adherence to the standards set forth in ISO 17025 has been validated and formally recognized through accreditations granted by an independent outside agency, American Industrial Hygiene Association (AIHA), on a site by site basis. As an additional measure to demonstrate its competency to perform the analyses it offers to its clients, EMLab P&K laboratories

also participate in a variety of different proficiency testing programs, including the Environmental Microbiology Proficiency Analytical Testing Program (EMPAT) sponsored by the American Industrial Hygiene Association.

As part of our continuous commitment to excellence, EMLab P&K laboratories are also inspected, licensed and/or accredited by a number of governmental agencies and independent associations in addition to those already mentioned above. The scope of services, accreditation certificates, and proficiency results can all be accessed at www.emlabpk.com.

References

1. Bioaerosols: Assessment and Control. Janet Macher, Ed., American Conference of Government Industrial Hygienists, Cincinnati, OH (1999).
2. EPA: The Inside Story. A Guide to Indoor Air Quality, United States Environmental Protection Agency and the United States Consumer Product Safety Commission, Washington DC (1995).
3. Health Canada: Exposure Guidelines for Residential Indoor Air Quality. Environmental Health Directorate. Health Protection Branch, Health Canada, Ottawa, Ontario (1989).
4. IIRC: Standard and Reference Guide for Professional Water Damage Restoration, 2nd Ed. Institute of Inspection, Cleaning and Restoration, Vancouver, WA (1999).
5. Field Guide for the Determination of Biological Contaminants in Environmental Samples. American Industrial Hygiene Association, Fairfax, VA (1996).
6. Standards of Practice for the Assessment of Indoor Environmental Quality, Volume I: Mold Sampling, Assessment of Mold Contamination. Indoor Environmental Standards Organization (2002).