Appendix 35-A
Fungi Fact Sheet

Biology of Fungi

The term "fungi" includes yeast, mold, mildew, as well as the morels, mushrooms, rusts, and smuts. Fungi live in the soil, on plants, and on dead or decaying matter. Outdoors, fungi play a key role in the breakdown of leaves, wood, and other plant debris. Unlike plants, they lack chlorophyll and must survive by digesting plant materials and other organic materials for food. Without fungi, our environment would be overwhelmed with large amounts of dead plant matter.

Mold produce spores to reproduce, just as some plants produce seeds. Spore sizes can range from less than 2 µm to more than 100 µm (1 µm = 10-6 meters or 1/25,000 of an inch). Mold spores can be found in both indoor and outdoor air and settle on indoor and outdoor surfaces. Fungal conidia and resting spores (chlamydospores) of many fungi persist for prolonged periods in dust on indoor surfaces. There is no practical way to eliminate all molds and mold spores in the indoor environment; the way to control indoor mold growth is to control moisture.

When mold spores land on a damp spot, they may begin growing and digesting whatever they are growing on in order to survive. When excessive moisture or water accumulates indoors, mold growth will often occur, particularly if the moisture problem remains undiscovered or un-addressed. Since mold gradually destroys the things they grow on, one can prevent damage to building materials and furnishings and save money by eliminating mold growth.

Health Effects

Research on fungi and health effects is ongoing. The most common reported health effects and symptoms from exposure to fungi are allergic reactions, asthma, and other respiratory complaints. Other health effects and symptoms associated with fungal exposures, as a result of fungi-contaminated building materials indoors, have been reported but are widely debated in the medical community. The types and severity of symptoms depend, in part, on the types of fungi present; the extent of an individual's exposure; the ages of the individuals; and the individuals' pre-existing sensitivities, allergies, or other medical conditions.

Most fungi produce antigenic proteins that can cause allergenic reactions in allergy sensitive individuals including conjunctivitis, rhinitis, bronchitis, asthma, and hypersensitivity pneumonitis. Fungi also produce volatile organic compounds (VOCs) during degradation of substances that cause the "moldy," "musty," or "earthy" odors associated with fungal contamination. VOCs can be irritating to the mucous membranes, cause headaches, and other symptoms. Specific reactions to fungal growth can include the following:

> **Allergic Reactions** – Inhaling or touching mold or mold spores may cause allergic reactions in sensitive individuals. Allergic reactions to mold are common and can be immediate or delayed. Allergic responses include hay fever-type symptoms, such as sneezing, runny nose, red eyes, and skin rashes (dermatitis). Mold spores and fragments can produce allergic reactions in sensitive individuals, regardless of whether the mold is dead or alive. Repeated

or single exposure to mold or mold spores may cause previously non-sensitive individuals to become sensitive, and repeated exposure has the potential to increase sensitivity.

Asthma – Fungi can trigger asthma attacks in persons who are allergic (sensitized) to fungi. The irritants produced by mold may also worsen asthma in non-allergic (non-sensitized) people.

Hypersensitivity Pneumonitis – Hypersensitivity pneumonitis may develop following either short-term (acute) or long-term (chronic) exposure to mold. The disease resembles bacterial pneumonia and is uncommon.

Irritant Effects – Fungal exposure can cause irritation of the eyes, skin, nose, throat, and lungs, and sometimes can create a burning sensation in these areas.

Opportunistic Infections – People with weakened immune systems (i.e., immuno-compromised or immuno-suppressed individuals) may be more vulnerable to infections by fungi. Aspergillus fumigatus, for example, has been known to infect the lungs of immuno-compromised individuals. In such cases, the infection occurs following inhalation of the mold spores by the immuno-compromised individual. Healthy individuals are usually not vulnerable to opportunistic infections from airborne fungal exposure. However, fungi can cause common skin diseases, such as athlete's foot, and infections.

Fungi can produce toxic substances called mycotoxins, which may be contained in mold spores or the building material on which the fungi is growing. Some mycotoxins cling to the surface of mold spores; others may be found within spores. More than two hundred (200) mycotoxins have been identified from common types of mold and many more remain to be identified. Some types of mold 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. Some types of mold can produce several mycotoxins, while other types of mold cannot produce mycotoxins. Furthermore, just because a type of mold has the ability to produce mycotoxins, it does not mean that the mold is always producing mycotoxins; the production of mycotoxins is depend on environmental conditions, the presence of competing mold species, and the building material on which the mold is growing. The presence of fungi in a building does not necessarily mean that mycotoxins are present or that they are present in large quantities.

Much of the information on the human health effects of inhalation exposure to mycotoxins comes from studies done in the workplace (where airborne mold concentrations have been several magnitudes higher than what is commonly reported in mold-contaminated buildings) and some case studies or case reports. Many symptoms and human health effects attributed to inhalation of mycotoxins have been reported including: mucous membrane irritation, skin rash, nausea, immune system suppression, acute or chronic liver damage, acute or chronic central nervous system damage, endocrine effects, and cancer. However, currently little is known about human health

effects due to inhalation of mycotoxins; more studies are needed to clarify the health effects related to inhalation of mycotoxins.

It is prudent to avoid exposure to mold and mycotoxins. Information on ingestion of mycotoxin-containing food, for both humans and animals, is more abundant. A wide range of health effects has been reported following ingestion of moldy foods including liver damage, nervous system damage, and immunological effects.

Controlling Fungal Growth Indoors

Indoor fungal colonization is varied and complex, and is directly affected by water availability, nutrients, temperature, and competing species. The single most important factor for amplification of fungi in the indoor environment is water. Even with all sources of moisture eliminated, high relative humidity (in excess of 60%) may promote fungal growth indoors. Keeping the indoor environment free from water intrusion (which implies no condensed moisture and a relative humidity less than 60%) will prevent fungal growth. When building materials get wet or moist, it is important to dry damaged areas and items within twenty to forty-eight (24-48) hours to prevent fungal growth from occurring.

Common sources or causes of water or moisture problems indoors include roof leaks, deferred maintenance, condensation associated with high humidity or cold spots in the building, localized flooding due to plumbing/piping failures or heavy rains, slow leaks in plumbing/piping fixtures, and malfunction or poor design of humidification and HVAC systems. Uncontrolled humidity can also be a source of moisture leading to fungal growth, particularly in hot, humid climates. If the conditions causing fungal growth are not corrected, fungal growth can continue and may recur, even after removal of existing fungi-contaminated building materials.

Moisture problems and their solutions differ from one climate to another. The Northeast is typically cold and wet; the Southwest is typically hot and dry; the South is typically hot and wet; and the Western Mountain states are typically cold and dry. All of these regions can have indoor moisture problems. For example, evaporative coolers used in the Southwest can encourage the growth of biological pollutants. In other hot regions, the use of air-conditioners, which cool the air quickly, may prevent the air-conditioners from running long enough to remove excess moisture from the air. The types of construction and weatherization for the different climates can lead to different problems and solutions.

Standards

Exposure limits for acceptable airborne concentrations of fungi, fungal spores, and fungal fragments have not been set. Currently, there are no federal regulations or standards for airborne fungal contaminants.

The majority of the information in this document was taken and reformatted from various United States Environmental Protection Agency (US EPA) publications that can be found on their web site at **http://www.epa.gov/**