Guidelines on Mold report Interpretation

Overview

- **The National Allergy Bureau** considers mold counts in air of 0-900 as low, to 2500 as moderate, to 25,000 as high, and above 25,000 as very high. At "high" levels most individuals with any sensitivity will experience symptoms. Acceptable levels for individual species vary since species toxicity varies widely as does spore size, weight, and other features which affect risk to building occupants. Eg. Aspergillis/Penicillium in a "clean" residential building study was at a mean of 230, in buildings known to have a moisture or flooding problem it was at 2235 and in mold contaminated buildings the figure was 36,037.
- **The University of Minnesota** data (www.dehs.umn.edu/iaq/fungus/mycoglos.html) presents this table for mold levels expressed in colony forming units per gram. WARNING: mold spores may be not viable (dead), wrong culture media may be used, or one species can overgrow another, etc. - so don't produce any colonies, but may be toxic if inhaled (such as some species of Penicillium). So I would not rely on culture data. But here it is:
- Concentration (Cfu/gram) Qualitative Assessment of Contamination
- Less than 10,000 low
- 10,000 to 100,000 medium
- 100,000 to 1,000,000 medium to heavy
- > 1,000,000 heavy
- Interpretation of Results
- Attempts to link bulk sources to airborne concentrations of fungal organisms are often problematic. The levels of fungal organisms vary by several orders of magnitude during the course of a day due to activity levels in an area and other factors such as fluctuations in temperature or humidity which cause the release of spores. The spores may no longer be viable and though allergenic and possibly toxigenic it will not grow on any media. Rapidly growing fungi may crowd out slower growing fungi. The wrong media may be used for viable sampling.

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- There are at present no strict numerical guidelines which are appropriate for assessing whether the contamination in an area is acceptable or not. Further investigation of contamination sources is warranted in the following circumstances.
- Total indoor counts are greater than outdoor fungal counts (compare indoor and outdoor ratios). This comparison is not valid when the outdoor sample was taken during or immediately after precipitation. It probably is not valid during some winter months where outdoor fungal counts are usually below that indoors.
- Comparison of indoor and outdoor levels of fungal organisms shows one of the following:

1. Organisms are present in the indoor sample and not in the outdoor sample.
2. The predominant organism found in the indoor sample is different than the predominant organism in the outdoor sample.
3. A monoculture of an organism is found in the indoor sample. The organism may be present in a mixed outdoor sample. It may be absent from samples taken in other areas of the building.
4. If the criteria in #2 are met and the organism is capable of producing a carcinogen (e.g., aflatoxin produced by Aspergillus flavus). The spores may be toxic by inhalation (e.g., satratoxin H in the case of Stachybotrys atra). The production of the toxin is very dependent on the source of nutrition for the organism.
5. In some cases, to comply with the American's With Disabilities Act, efforts will be taken to further reduce levels even though they are not identified as a problem in section 1, 2 and 3. This would be the case where an individual has been diagnosed by a physician to be allergic to a specific fungal organism. Efforts may then be made to further reduce exposure through increase filtration of the air. There are often problems linking an environmental exposure to an allergy test. The antigenic material produced by a fungus of a particular genus will vary according to species or a strain within the species and vary with the source of nutrition for the organism. Other factors also influence the antigenicity of the fungal spore. Thus, establishing a direct link between environmental exposure and the results of an allergy test is often problematic. Removal of the person from the area is often the most successful approach.
6. An opportunistic fungal pathogen is found in an area which houses individuals who are immune compromised.
7. Aggressive sampling and sampling of suspected sources of fungal organisms is often warranted. The amount of fungi present in an air sample is highly variable. Changes in airflow, humidity, light level and temperature can all trigger a spore release. A single air sample will often underestimate the fungal contamination in the air.

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8. A general rule of thumb:
1. If the numbers are high (air or bulk)
2. Fungi indoors are different from outdoors or noncompliant controls
3. The fungi are allergenic or toxic,
4. The area is likely to be disturbed,
5. There is or was a source of water or high relative humidity, and
6. There is or was a source of water or high relative humidity, and
7. People are occupying this area or have contact with air from this location.
8. There are immune compromised individuals or individuals with elevated sensitivity to molds - there may be a problem.

The American Conference of Government Industrial Hygienists:

(ACGIH) stated (Harriet Burge et. al) stated in 1987 that indoor mold levels are generally less than 1/3 the outdoor level and that when indoor mold is at more than this level remedial action should betaken to find the source of the elevated counts and to clean it up.

Other proposals:

I have included a limit of 500 CFU/cubic meter in winter indoors in subartic climates (Reponen et al.1990). I suspect that focusing only on "colony-forming-units" (that is, viable mold that will grow) is a reliable way to check out a building. Elsewhere I have cited the errors and limitations of using cultures to check for viable mold, and I suggest that even non-viable mold may be allergenic or toxic.

For mold spores, other more qualitative guidelines also exist. Although these too are unofficial, they do serve as objective indicators of potential contamination.

Agency or Organization	**Suggested Guideline**
U.S. Public Health Service	100 - 250 CFUs m^{-3}
World Health Organization	50 CFUs m^{-3} (any single species) 150 CFUs m^{-3} (total species)
Indoor Air Quality Association	50 CFUs m^{-3} (any single species) 300 CFUs m^{-3} (total species)
Health Canada	50 CFUs m^{-3} (any single species) 150 CFUs m^{-3} (total species)

Mold glossary

Absidia sp.

A zygomycete fungus. Reported to be allergenic. May cause mucorosis in immune compromised individuals. The sites of infection are the lung, nasal sinus, brain, eye and skin. Infection may have multiple sites.

Acremonium sp. (Cephalosporium sp.)

Reported to be allergenic. Can produce a trichothecene toxin that is toxic if ingested. It was the primary fungus identified in at least two houses where the occupant complaints were nausea, vomiting and diarrhea. Asexual state of *Emericellopsis* sp., *Chaetomium* sp., and *Nectripsis* sp. It can produce mycetomas, infections of the cornea and nails.

Alternaria sp.

Aw - 0.89. Conidia dimensions: 18-83 x 7-18 microns. A very common allergen with an IgE mediated response. It is often found in carpets, textiles and on horizontal surfaces in building interiors. Often found on window frames. Outdoors it may be isolated from samples of soil, seeds and plants. It is commonly found in outdoor samples. The large spore size, 20 - 200 microns in length and 7 - 18 microns in sizes, suggests that the spores from these fungi will be deposited in the nose, mouth and upper respiratory tract. It may be related to bakers' asthma. It has been associated with hypersensitivity pneumonitis. The species *Alternaria alternata* is capable of producing tenuazonic acid and other toxic metabolites that may be associated with disease in humans or animals. Common cause of extrinsic asthma (immediate-type hypersensitivity: type I). Acute symptoms include edema and bronchiospasms; chronic cases may develop pulmonary emphysema.

Amerospore

A spherical or oval single-celled fungal spore that is practically unidentifiable by itself. Genera with this type of spore include, but are not limited to, *Aspergillus*, *Penicillium*, and *Trichoderma.*
For example, *Penicillium* is easily identifiable when sampling using culturing techniques. However, when sampling with non-culturing techniques, such as spore traps or tape-lifts, the free spores with no remnants of the fungal structure are indistinguishable from *Aspergillus* and various other genera that also produce small round and oval spores with little or no pigmentation. Due to this fact, Penicillium will often be categorized on laboratory reports in an "amerospore" and/or "Aspergillus/Penicillium" group.

Arthrinium sp.

widespread saprophyte found on decomposing plant material, particularly grasses, and on soil. It is a white, fuzzy mold. It should be considered to be an allergen. This

fungus has also been documented in various subcutaneous infections. No diseases related to toxic effects have been recorded to date.

Ascospore

A spore borne in a special cell called an ascus. Spores of this type are reported to be allergenic.
All ascomycetes, members of a group of fungi called Ascomycotina, have this type of spore. The minute black dots on rotting wood and leaves or the little cups on lichens are examples of ascomycetes; another is the "truffle" mushroom.

Aspergillus caesiellus

This species is only occasionally pathogenic.

Aspergillus candidus

Aw 0.75. Conidia dimensions: 2.5-4 microns. Found in warm soils, grain and in the secondary decay of vegetation. Associated with respiratory complaints in a recent house investigation. Can produce the toxin petulin that may be associated with disease in humans and other animals.

Aspergillus carneus

This species is only occasionally pathogenic.

Aspergillus clavatus

Conidia dimensions: 3-4.5 x 2.5-4.5 microns. Found in soils and animal manure. Can produce the toxin petulin that may be associated with disease in humans and other animals. This species is only occasionally pathogenic.

Aspergillus deflectus

This species is only occasionally pathogenic.

Aspergillus flavus

Aw 0.78. Conidia dimensions: 3-6 microns or 3-5 microns. It grows on moldy corn and peanuts. It can be found in warm soil, foods and dairy products. Some strains are capable of producing a group of mycotoxins- in the aflatoxin group. Aflatoxins are known animal carcinogens. There is limited evidence to suggest that this toxin is a human carcinogen. The toxin is poisonous to humans by ingestion. It may also result in occupational disease via inhalation. Experiments have indicated that it is teratogenic and mutagenic. It is toxic to the liver. It is reported to be allergenic. Its presence is associated with reports of asthma. It can be found in water-damaged carpets. The production of the fungal toxin is dependent on the growth conditions and on the substrate used as a food source. This fungus is associated with aspergillosis of the lungs and/or disseminated aspergillosis. This fungus is occasionally identified as the cause of corneal, otomycotic and nasoorbital infections.

Aspergillus fumigatus

Aw 0.82; Optimum> 0.97. Conidia dimensions: 2-3.5 microns. Major cause of aspergillosis. This organism causes both invasive and allergic aspergillosis. Aspergillosis affects individuals who are immune compromised. It is considered a human pathogen. It grows well at 35 degrees C. It is commonly found outdoors in compost piles with temperatures higher than 40 degrees C, in mild to warm soils and on cereals.

Aspergillus glaucus

Conidia dimensions: 5-6.5 microns. Common outdoor fungus in the winter. It is reported to be allergenic. This species is only occasionally pathogenic. It can grow on leather. This fungus can grow at low moisture levels on grains, sugary food products, meat and wool. The ascomycetous state is *Eurotium* sp.

Aspergillus nidulans

Aw 0.78. Conidia dimensions: 2-4 microns. Found in mild to warm soils and on slowly decaying plants. Can produce the mycotoxin sterigmatocystin. This toxin has been shown to produce liver and kidney damage in lab animals. This fungus is associated with aspergillosis of the lungs and/or disseminated aspergillosis. This species is only occasionally pathogenic.

Aspergillus niger

Aw 0.77; Optimum> 0.97. Conidia dimensions: 3.5 - 5 microns or 4 to 5 microns. Less common cause of aspergillosis. It has a musty odor. It is commonly found in the environment on textiles, in soils, grains, fruits and vegetables. It has been reported to cause skin and pulmonary infections. It is a common cause of fungal related ear infections-otomycosis.

Aspergillus ochraceus

Aw 0.77. Conidia dimensions: 2.5 - 3 microns. Found in grains, soil and salted food products. It is not usually associated with decaying vegetation. Can produce a kidney toxin ochratoxin a may produce ochratoxicosis in humans. This is also known as Balkan nephropathy. The toxin is produced at optimum growth conditions at 25 degrees C and high moisture conditions. The ochratoxin may also be produced by other *Aspergillus* sp. and *Penicillium* sp. Other toxins that can be produced by this fungus include penicillic acid, xanthomegnin and viomellein. These are all reported to be kidney and liver toxins.

Aspergillus oryzae

This species is only occasionally pathogenic.

Aspergillus parasiticus

Some strains are capable of producing a group of mycotoxins- in the aflatoxin group. Aflatoxins are known animal carcinogens. There is limited evidence to suggest that this toxin is a human carcinogen. The toxin is a poisonous to humans by ingestion. Experiments have indicated that it is teratogenic and mutagenic. It is toxic to the liver. The production of the fungal toxin is dependent on the growth conditions and on the substrate used as a food source.

Aspergillus/Penicillium

These are two of the most commonly found allergenic fungi in problem buildings.
Aspergillus comes in many varieties (species). Many of the varieties produce toxic substances. It may be associated with symptoms such as sinusitis, allergic bronchiopulmonary aspergillosis, and other allergic symptoms.
Penicillium is a variety of mold that is very common indoors and is found in increased numbers in problem buildings. It also has many varieties, some of which produce toxic substances. The symptoms are allergic reactions, mucous membrane irritation, headaches, vomiting, and diarrhea.
Because the spores of *Aspergillus* and *Penicillium* are very similar, they are not differentiated by microscopic analysis and are reported together.

Aspergillus penicilloides

Conidia dimensions: 3-3.5 x 4-5 microns. Can grow in areas with low water activity. It is found in house dust and food.

Aspergillus restrictus

This species is only occasionally pathogenic.

Aspergillus sp.

Aw 0.75 - 0.82. Reported to be allergenic. Members of this genus are reported to cause ear infections. Many species produce mycotoxins that may be associated with disease in humans and other animals. Toxin production is dependent on the species or a strain within a species and on the food source for the fungus. Some of these toxins have been found to be carcinogenic in animal species. Several toxins are considered potential human carcinogens. Common cause of extrinsic asthma (immediate-type hypersensitivity: type I). Acute symptoms include edema and bronchiospasms; chronic cases may develop pulmonary emphysema; may also be associated with sinusitis, allergic bronchiopulmonary aspergillosis, and other allergic symptoms.

Aspergillus sydowi

This species is only occasionally pathogenic.

Aspergillus terreus

Aw 0.78. Conidia dimensions: 1.8-2.4 microns or 2 - 2.5 microns. Aleurospores 6 - 7 microns in diameter are also produced. Found in warmer soil and in grains, straw, cotton and decomposing vegetation. Can produce the toxin patulin and citrinin that may be associated with disease in humans and other animals. This fungus is associated with aspergillosis of the lungs and or disseminated aspergillosis. Found as an isolate from otomycosis - ear infection, and onychomycosis - infection of finger or toenails.

Aspergillus ustus

This species is only occasionally pathogenic.

Aspergillus versicolor

Aw 0.78. Conidia dimensions: 2-3.5 microns. It is commonly found in soil, hay, cotton and dairy products. It can produce a mycotoxin sterigmatocystin and cyclopiaxonic acid. These toxins can cause diarrhea and upset stomach. It is reported to be a kidney and liver carcinogen. This species is only occasionally pathogenic.

Aureobasidium sp.

Found in soil, forest soils, fresh water, aerial portion of plants, fruit, marine estuary sediments, wood. Allergen, Type I allergies (hay fever, asthma). Type III hypersensitivity pneumonitis: "humidifier fever", "sauna taker's lung". Growth indoors is widespread where moisture accumulates- especially bathrooms and kitchens- on shower curtains, tile grout, windowsills, textiles, liquid waste materials. Potential toxic production is not known. Rare reports of: isolates from skin lesions, keratitis, spleen abscess in a lymphoma patient, blood isolate from a leukemic patient.

Basidiomycetes

Members of a group of fungi called Basidiomycotina, which includes mushrooms and puffballs. They produce spores that are formed on the outside of a special cell called the basidium.

Basidiospore

Spore from basidiomycetes. Many varieties are reported to be allergenic.

Bipolaris sp.

A fungus with large spores that could be expected to be deposited in the upper respiratory tract. This fungus can produce the mycotoxin - sterigmatocystin, which has been shown to produce liver and kidney damage when ingested by laboratory animals.

Blastomyces sp.

Human pathogen. The fungus is commonly found in soil. It is a dimorphic fungus that has filamentous fungus when grown at 25 degrees C. and a yeast form at 37 degrees C.

Botrytis sp.

Aw 0.93. Conidia dimensions: 7-14 x 5-9 microns. It is parasitic on plants and soft fruits. Found in soil and on house plants and vegetables, it is also known as "gray mold". It causes leaf rot on grapes, strawberries, lettuce, etc. It is a well-known allergen, producing asthma type symptoms in greenhouse workers and "wine grower's lung".

Candida sp.

Part of the normal flora of mouth and other mucous membranes in the body. Thrush and other diseases caused by *Candida albicans* usually occur after prolonged treatment with antibiotics or steroids. The environment is not a likely source of exposure for this fungus. Cells from the organism are usually not airborne. Reported to be allergenic.

Cephalosporium sp.

See Acremonium sp.

Chaetomium sp.

large ascomycetous fungus producing perithecia. It is found on a variety of substrates containing cellulose, including paper and plant compost. It has been found on paper in sheetrock. It can produce an *Acremonium*-like state on fungal media. Varieties are considered allergenic and have been associated with peritonitis, cutaneous lesions, and system mycosis.

Cladosporium fulvum (Fulvia fulva)

Conidia dimensions: 12-47 x 4-10 microns. It is found on the leaves of tomatoes.

Cladosporium herbarum

Aw 0.88. Conidia dimensions: 5-23 x 3-8 microns. It is found on dead plants, woody plants, food, straw, soil, paint and textiles.

Cladosporium macrocarpum

Conidia dimensions: 9-29 x 5-13 microns. It is found on dead plants, woody plants, food, straw, soil, paint, and textiles.

Cladosporium sp. (Hormodendrum sp.)

Aw 0.88; Aw 0.84. Most commonly identified outdoor fungus. The outdoor numbers are reduced in the winter. The numbers are often high in the summer. Often found indoors in numbers less than outdoor numbers. It is a common allergen. Indoor *Cladosporium* sp. may be different than the species identified outdoors. It is commonly found on the surface of fiberglass duct liners in the interior of supply ducts. A wide variety of plants are food sources for this fungus. It is found on dead plants, woody plants, food, straw, soil, paint, and textiles. Produces greater than 10 antigens. Antigens in commercial extracts are of variable quality and may degrade within weeks of preparation. Common cause of extrinsic asthma (immediate-type hypersensitivity: type I). Acute symptoms include skin lesions, eye ulceration, mycosis (including onychomycosis, an infection of the nails of the feet or hands) edema and bronchiospasms; chronic cases may develop pulmonary emphysema.

Cladosporium sphaerospermum

Conidia dimensions: 3-4.5 microns. It is found as a secondary invader of plants, food, soil, paint and textiles.

Conidium

A thin-walled, asexual spore that is borne exogenously on a conidiophore and is deciduous at maturity. (plural form: conidia.)

Conidia, unidentified

These are mold spores that do not show morphological characteristics that allow identification. Because there are tens of thousands of types of fungi, many fall into the "other" or "unknown" category. If they are present in significant numbers, additional measures can be taken to identify them. When spore counts are listed in the category: "Unidentified Conidia" their numbers are considered "normal".

Conidobolus sp.

Can cause a chronic inflammatory disease of the nasal mucosa (entomophthoromycosis).

Cryptococcus neoformans

A basidiomycetous encapsulated fungal organism found worldwide, mainly around pigeon roosts and soil contaminated with decaying pigeon or chicken droppings. It is generally accepted that the organism enters the host by the respiratory route in the form of dehydrated haploid yeast or as basidiospores. Hematogenously spreading to extra pulmonary tissues, its predilection for the brain means infected persons usually contract meningoencephalitis, which can be fatal.

Cryptostroma corticale

Conidia dimensions: 4-6.5 x 3.5-4 microns. Found on the bark of maple and sycamore trees and on stored logs.

Cunninghamella sp.

Can cause disseminated and pulmonary infections in immune compromised hosts.

Curvularia sp.

Reported to be allergenic and has been associated with allergic fungal sinusitis. It may cause corneal infections, mycetoma, and infections in immune compromised hosts.

Dreschlera sp.

Conidia dimensions: 40-120 x 17-28 microns. Found on grasses, grains and decaying food. It can occasionally cause a corneal infection of the eye.

Epicoccum sp.

Conidia dimensions: 15-25 microns. A common allergen. It is found in plants, soil, grains, textiles and paper products.

Epidermophyton sp.

Can cause infections of skin and nails.

Fungus

Neither animals nor plants, these saprophytic and parasitic spore-producing organisms rate a taxonomic kingdom of their own. Fungi include molds, rusts, mildews, smuts, mushrooms, puffballs, and yeasts. It is estimated that more than 1.5 million species of fungi exist.

Fusarium solani

Aw 0.90. Macroconidia dimensions: 27-52 x 4.4-6.8; Microcondia dimensions: 8-16 x 2-4 microns. Found in plants and soils. Can produce trichothecene toxins that may be associated with disease in humans and animals.

Fusarium sp.

Aw 0.90. A common soil fungus. It is found on a wide range of plants. It is often found in humidifiers. Several species in this genus can produce potent trichothecene toxins. The trichothecene (scirpene) toxin targets the following systems: circulatory, alimentary, skin, and nervous. Produces vomitoxin on grains during unusually damp growing conditions. Symptoms may occur either through ingestion of contaminated grains or possibly inhalation of spores. The genera can produce hemorrhagic syndrome in humans (alimentary toxic aleukia). This is characterized by nausea, vomiting, diarrhea, dermatitis, and extensive internal bleeding. Reported to be allergenic. Frequently involved in eye, skin, and nail infections.

Geotrichum sp.

Aw 0.90. Conidia dimensions: 6-12 x 3-6 microns. Aw 0.90. A common contaminant of grains, fruits, dairy products, paper, textiles, soil, and water; often present as part of the normal human flora. The species *Geotrichum candidum* can cause a secondary infection (geotrichosis) in association with tuberculosis. This rare disease can cause lesions of the skin, bronchi, mouth, lung, and intestine.

Gliocladium sp.

A fungus that is structurally similar to *Penicillium* sp. It is reported to be allergenic.

Helminthosporium sp.

Reported to be allergenic.

Histoplasma sp.

A fungus that has filamentous growth at 25 degrees C. and yeast growth at 37 degrees C. It is reported to be a human pathogen. It may be associated with birds.

Humicula sp.

Grows on products with high cellulose
content. These fungi are also found in soil and on plant debris.

Hyaline Mycelia

Sterile mycelia that is white or transparent. No fruiting structures are produced by the mycelia. Visual identification of these organisms is not possible. Often associated with allergic symptoms.

Memnoniella sp.

A cellulolytic fungus that is very closely related to *Stachybotrys* sp. Both fungi have a worldwide distribution and are often found together and are commonly found in soil. Recent studies on mycotoxins revealed that *Memnoniella echinata* can have toxicity similar to that of some isolates of *Stachybotrys chartarum*. Both produce varying amounts of simple trichothecenes. Thus, it is suggested that *Memnoniella* sp. should also be considered potentially dangerous in indoor air. The major difference between the two fungi is that the conidia of *Memnoniella* sp. are in long persistent chains while those of *Stachybotrys* are aggregated in slimy heads. Also the aerodynamic diameter of *Memnoniella* sp. conidia is smaller and it would be expected to have an even greater potential to penetrate deep into lungs than the conidia of *Stachybotrys* sp.

Microsporum sp.

Causes ringworm in humans.

Mold

Molds are a group of organisms that belong to the taxonomic kingdom of Fungi. There are over 20,000 species of mold. Molds reproduce by making spores. Mold spores waft through the indoor and outdoor air continually. When mold spores land on a damp spot indoors, they may begin growing and digesting whatever they are growing on. Molds can grow on virtually any organic substance, as long as moisture and oxygen are present.

Monilia sp.

Reported to be allergenic. This fungus produces soft rot of tree fruits. Other members produce a red bread mold. It is infrequently involved in corneal eye infections.

Mucor sp.

often found in soil, dead plant material, horse dung, fruits and fruit juice. It is also found in leather, meat, dairy products, animal hair, and jute. A Zygomycetes fungus that may be allergenic (skin and bronchial tests). This organism and other Zygomycetes will grow rapidly on most fungal media. May cause mucorosis in immune compromised individuals. The sites of infection are the lung, nasal sinus, brain, eye, and skin. Infection may have multiple sites.

Myxomycetes

Members of a group of fungi that is included in the category of "slime molds". They're occasionally found indoors, but mainly reside in forested regions on decaying logs, stumps, and dead leaves. Myxomycetes display characteristics of fungi *and* protozoans. In favorable (wet) conditions they exhibit motile, amoeba-like cells, usually bounded only by a plasma membrane, that are variable in size and form. During dry spells, they form a resting body (sclerotium) with dry, airborne spores. These fungi are not known to produce toxins, but can cause hay fever and asthma.

Nigrospora sp.

Commonly found in warm climates, this mold may be responsible for allergic reactions such as hay fever and asthma. It is found on decaying plant material and in the soil. It is not often found indoors.

Oidium sp.

The asexual phase of *Erysiphe* sp. It is a plant pathogen causing powdery mildews. It is very common on the leaves stems, and flowers of plants. The health effects and allergenicity have not been studied. It does not grow on non-living surfaces such as wood or drywall.

Paecilomyces sp.

Commonly found in soil and dust, less frequently in air. *P. variotii* can cause paecilomycosis. Linked to wood-trimmers disease and humidifier associated illnesses. They are reported to allergenic. Some members of this genus are reported to cause pneumonia. It may produce arsine gas if growing on arsenic substrate. This can occur on wallpapers covered with Paris green.

Papulospora sp.

These fungi are found in soil, textiles, decaying plants, manure, and paper.

Penicillium sp.

Aw 0.78 - 0.88. A wide number of organisms have been placed in this genus. Identification to species is difficult. Often found in aerosol samples. Commonly found in soil, food, cellulose and grains. It is also found in paint and compost piles. It may cause hypersensitivity pneumonitis, allergic alveolitis in susceptible individuals. It is reported to be allergenic (skin). It is commonly found in carpet, wallpaper, and in interior fiberglass duct insulation. Some species can produce mycotoxins. Common cause of extrinsic asthma (immediate-type hypersensitivity: type I). Acute symptoms include edema and bronchiospasms; chronic cases may develop pulmonary emphysema. It may also cause headaches, vomiting, and diarrhea.

Periconia sp.

found in soil, blackened and dead herbaceous stems leaf spots, grasses, rushes, and sedges. Almost always associated with other fungi. Rarely found growing indoors. Reportedly associated with a rare case of mycotic keratitis.

Perithecium

A fruiting body of a fungus in which some types of spores (including ascospores) are produced. (Plural form: perithecia)

Peronospora sp.

These species are plant pathogens and the genus is one that causes downy mildews. *Peronospora* is very common and is an obligate parasite (obligate parasites cannot grow on non living environmental surfaces) found on leaves, stems, flowers, and fruits of living higher plants. *Peronospora* sp. may be identified in air on spore trap samples since spores have a distinctive morphology. The spores may also be seen in dust as part of the normal influx of outdoor microbial particles. As of this writing, allergenicity has not been studied and no information is available regarding health effects or toxicity.

Phoma sp.

A common indoor air allergen. It is similar to the early stages of growth of *Chaetomium* sp. The species are isolated from soil and associated plants (particularly potatoes). Produces pink and purple spots on painted walls. It may have antigens that cross-react with those of *Alternaria* sp. It will grow on butter, paint, cement, and rubber. It may cause phaeohyphomycosis a systematic or subcutaneous disease.

Pithomyces sp.

A common mold found on dead leaves, plants, soil and especially grasses. Causes facial eczema in ruminants. It exhibits distinctive multi-celled brown conidia. It is not know to be a human allergen or pathogen. It is rarely found indoors, although it can grow on paper.

Rhizomucor sp.

The Zygomycetous fungus is reported to be allergenic. It may cause mucorosis in immune compromised individuals. It occupies a biological niche similar to *Mucor* sp. It is often linked to occupational allergy. May cause mucorosis in immune compromised individuals. The sites of infection are the lung, nasal sinus, brain, eye, and skin. Infection may have multiple sites.

Rhizopus sp.

The Zygomycetous fungus is reported to be allergenic. It may cause mucorosis in immune compromised individuals. It occupies a biological niche similar to *Mucor* sp. It is often linked to occupational allergy. May cause mucorosis in immune compromised individuals. The sites of infection are the lung, nasal sinus, brain, eye, and skin. Infection may have multiple sites.

Rhodotorula sp.

Reddish yeast typically found in moist environments such as carpeting, cooling coils, and drain pans. In some countries it is the most common yeast genus identified in indoor air. This yeast has been reported to be allergenic. Positive skin tests have been reported. It has colonized terminally ill patients.

Rusts (and Smuts)

These fungi are associated with plant diseases. In the classification scheme of the fungi, the smuts have much in common with the rusts, and they are frequently discussed together. Both groups produce wind-borne, resistant teliospores that serve as the basis for their classification and their means of spread. Rusts usually attack vegetative regions (i.e., leaves and stems) of plants; smuts usually are associated with the reproductive structures (seeds). They can cause hay fever and asthma.

Saccharomyces sp.

Reported to be allergenic. Baker's yeast.

Scopulariopsis sp.

It may produce arsine gas if growing on arsenic substrate. This can occur on wallpapers covered with Paris green. It has been found growing on a wide variety of materials including house dust. It is associated with type III allergy.

Sepedonium

Most easily recognized by the spores, which are colorless to yellow, spiny, round, 1-celled, and produced singly at the ends of short filaments. Sometimes phialides of the *Acremonium* or *Gabarnaudia* type may also occur. A few species of *Mortierella*, as well as the human pathogen *Histoplasma capsulatum*, produce spores resembling those of *Sepedonium*. Isolated from soil, but most commonly parasitized mushrooms.

Serpula lacrymans

Common cause of extrinsic asthma (immediate-type hypersensitivity: type I). Acute symptoms include edema and bronchiospasms; chronic cases may develop pulmonary emphysema.

Smuts

See Rusts.

Spore

The means by which molds reproduce. Spores are microscopic (2-100 micrometers) and various shapes. Distribution can be accomplished by a breeze, water droplet, or a person or animal passing by. They can even be discharged by the mold (usually under moist conditions or high humidity).

Sporobolomyces sp.

Reported to be allergenic.

Sporothrix sp.

Can cause sporotrichosis, but usually only in populations that are immune compromised.

Sporotrichum sp.

Reported to be allergenic. See also *Sporothrix* sp. for there is some taxonomic confusion between these two genera. This genus does not cause sporotrichosis.

Stachybotrys sp.

Aw - 0.94 , optimum Aw ->0.98. Several strains of this fungus (*S. atra, S. chartarum* and *S. alternans* are synonymous) may produce a trichothecene mycotoxin- Satratoxin H - which is poisonous by inhalation. The toxins are present on the fungal spores. This is a slow growing fungus on media. It does not compete well with other rapidly growing fungi. The dark colored fungus grows on building material with high cellulose content and low nitrogen content. Areas with a relative humidity above 55%, and are subject to temperature fluctuations, are ideal for toxin production. Individuals with chronic exposure to the toxin produced by this fungus reported cold and flu symptoms, sore throats, diarrhea, headaches, fatigue, dermatitis, intermittent local hair loss and generalized malaise. Other symptoms include coughs, rhinitis, nosebleed, a burning sensation in the nasal passages, throat, and lungs, and fever. The toxins produced by this fungus will suppress the immune system affecting the lymphoid tissue and the bone marrow. Animals injected with the toxin from this fungus exhibited the following symptoms: necrosis and hemorrhage within the brain, thymus, spleen, intestine, lung, heart, lymph node, liver, and kidney. Affects by absorption of the toxin in the human lung are known as pneumomycosis.
This organism is rarely found in outdoor samples. It is usually difficult to find in indoor air samples unless it is physically disturbed (or possibly -this is speculation- a drop in the relative humidity). The spores are in a gelatinous mass. Appropriate media for the growth of this organism will have high cellulose content and low nitrogen content. The spores will die readily after release. The dead spores are still allergenic and toxigenic. Percutaneous absorption has caused mild symptoms.

Stemphylium sp.

Reported to be allergenic. Isolated from dead plants and cellulose materials.

Syncephalastrum sp.

Can cause a respiratory infection characterized by a solid intracaitary fungal ball.

Torula sp.

Found outdoors in air, soil, on dead vegetation, wood, and grasses. Also found indoors on cellulose materials. Reported to be allergenic and may cause hay fever and asthma.

Trichoderma sp.

It is commonly found in soil, dead trees, pine needles, paper, and unglazed ceramics. It often will grow on other fungi. It produces antibiotics that are toxic to humans. It has been reported to be allergenic. It readily degrades cellulose.

Trichophyton sp.

Can cause ringworm; athlete's foot, skin, nail, beard and scalp. Rreported to be allergenic. Found on soil and skin.

Trichothecium sp.

Aw 0.90. Conidia dimensions: 12-23 x 8-10 microns. Found in decomposing vegetation, soil, corn seeds, and in flour. The species *Trichothecium roseum* can produce a trichothecene toxin that may be associated with disease in humans and other animals. Reported to be allergenic.

Tritirachium sp.

Reported to be allergenic.

Ulocladium sp.

Aw 0.89. Isolated from dead plants and cellulose materials. Found on textiles.

Verticillium sp.

Conidia dimensions: 2.3-10 x 1-2.6 microns. Found in decaying vegetation, on straw, soil and arthropods. A rare cause of corneal infections.

Wallemia sp.

Aw 0.75. Conidia dimensions: 2.5-3.5 microns. Found in sugary foods, salted meats, dairy products, textiles, soil, hay and fruits.

Yeast

various yeasts are commonly identified on air samples. Some yeast is reported to be allergenic. They may cause problems if a person has had previous exposure and developed hypersensitivity. Yeasts may be allergenic to susceptible individuals when present in sufficient concentrations.

Table1- The following table lists mycotoxins that are produced by certain types of fungi:

Fungi	Mycotoxin
Acremonium crotocinigenum	Crotocin
Aspergillus favus	Alfatoxin B, cyclopiazonic acid
Aspergillus fumigatus	Fumagilin, gliotoxin
Aspergillus carneus	Critrinin
Aspergillus clavatus	Cytochalasin, patulin
Aspergillus Parasiticus	Alfatoxin B
Aspergillus nomius	Alfatoxin B
Aspergillus niger	Ochratoxin A, malformin, oxalicacid
Acremonium crotocinigenum	Crotocin
Aspergillus nidulans	Sterigmatocystin
Aspergillus ochraceus	Ochratoxin A, penicillic acid
Aspergillus versicolor	Sterigmatocystin, 5 ethoxysterigmatocystin
Aspergillus ustus	Ausdiol, austamide, austocystin,brevianamide
Aspergillus terreus	Citreoviridin
Alternaria	Alternariol, altertoxin, altenuene, altenusin, tenuazonic acid
Arthrinium	Nitropropionic acid
Bioploaris	Cytochalasin, sporidesmin, sterigmatocystin
Chaetomium	Chaetoglobosin A,B,C. Sterigmatocystin
Cladosporium	Cladosporic acid
Clavipes purpurea	Ergotism
Cylindrocorpon	Trichothecene
Diplodia	Diplodiatoxin
Fusarium	Trichothecene, zearalenone
Fusarium moniliforme	Fumonisins
Emericella nidulans	Sterigmatocystin
Gliocladium	Gliotoxin
Memnoniella	Griseofulvin , dechlorogriseofulvin, epi-decholorgriseofulvin, trichodermin, trichodermol
Myrothecium	Trichothecene
Paecilomyces	Patulin, viriditoxin
Penicillium aurantiocandidum	Penicillic acid
Penicillium aurantiogriseum	Penicillic acid
Penicillium brasilanum	Penicillic acid
Penicillium brevicompactum	Mycophenolic acid
Penicillium camemberti	Cyclopiazonic acid
Penicillium carneum	Mycophenolic acid, Roquefortine C
Penicillium crateriforme	Rubratoxin
Penicillium citrinum	Citrinin
Penicillium commune	Cyclopiazonic acid
Penicillium crustosum	Roquefortine C
Penicillium chrysogenum	Roquefortine C
Penicillium discolor	Chaetoglobosin C
Penicillium expansum	Citrinin, Roquefortine C
Penicillium griseofulvum	Roquefortine C, cyclopiazonic acid, griseofulvin
Penicillium hirsutum	Roquefortine C
Penicillium hordei	Roquefortine C

Cont'd

Table1- The following table lists mycotoxins that are produced by certain types of fungi:, Continued

Fungi	Mycotoxin
Penicillium nordicum	Ochratoxin A
Penicillium paneum	Roquefortine C
Penicillium palitans	Cyclopiazonic acid
Penicillium polonicum	Penicillic acid
Penicillum roqueforti	Roquefortine C, Mycophenolic acid
Penicillium veridicatum	Penicillic acid
Penicillium verrucosum	Citrinin, ochratoxin A
Penicillium/ Aspergillus	Patulin
Penicillium/ Aspergillus/Alternaria	Glitoxin
Phomopsis	Macrocyclic trichothecenes
Phoma	Brefeldin, cytochalasin, secalonic acid, tenuazonic acid
Pithomyces	Sporidesmin
Rhizoctonia	Slaframine
Rhizopus	Rhizonin
Sclerotinia	Furanocoumarins
Stachybotrys chartarum	Iso-satratoxin F, roridin E, L-2, satratoxin G & H, trichodermin, trichodermol, trichothecene
Torula	Cytotoxins
Trichoderma	Trichodermin, trichodermol, gliotoxin
Trichothecium	Trichothecene
Wallemia	Walleminol
Zygosporium	Cytochalasin