

# Fungal Descriptions

## 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* can produce 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 bronchospasms; chronic cases may develop pulmonary emphysema.

## 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/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 bronchopulmonary 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. Due to the morphological similarity of *Aspergillus* and *Penicillium*, they are not differentiated by microscopic analysis and are reported together.

## 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 bronchospasms; chronic cases may develop pulmonary emphysema; may also be associated with sinusitis, allergic bronchopulmonary aspergillosis, and other allergic symptoms.

## Aureobasidium

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*Aureobasidium pullulans* is a ubiquitous and generalistic black, yeast-like fungus that can be found in different environments (e.g., soil, water, air, and limestone). It is well known as a naturally occurring epiphyte or endophyte of a wide range of plant species (e.g. apple, grape, cucumber, green beans, cabbage) without causing any symptoms of disease. *A. pullulans* has a high importance in biotechnology for the production of different enzymes, siderophores and pullulan. Furthermore, *A. pullulans* is used in biological control of plant diseases, especially storage diseases.

Chronic human exposure to *A. pullulans* via humidifiers or air conditioners can lead to hypersensitivity pneumonitis (extrinsic allergic alveolitis) or "humidifier lung". This condition is characterized acutely by dyspnea, cough, fever, chest infiltrates, and acute inflammatory reaction. The condition can also be chronic, and lymphocyte mediated. The chronic condition is characterized radiographically by reticulonodular infiltrates in the lung, with apical sparing. The strains causing infections in humans were reclassified to *A. melanogenum*.

## Basidiospore

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

## Bipolaris sp.

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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".

## Botrytis sp.

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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.

## Cercaspora

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Common outdoors in agricultural areas, especially during harvest. Parasite of higher plants, causing leaf spot. Commonly found as parasites on higher plants.

## Chaetomium sp.

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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 sp.**

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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 bronchospasms; chronic cases may develop pulmonary emphysema.

## **Curvularia sp.**

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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.**

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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.**

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

## **Fusarium sp.**

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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.

## **Myxomycetes**

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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.

## Memnoniella

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Contaminant found most often with *Stachybotrys* on wet cellulose. Forms in chains, but it are very similar to *Stachybotrys* and sometimes is considered to be in the *Stachybotrys* family. Certain species do produce toxins very similar to the ones produced by *Stachybotrys chartarum* and many consider the IAQ importance of *Memnoniella* to be on par with *Stachybotrys*. Allergenic and infectious properties are not well studied.

## Nigrospora sp.

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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.

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The asexual phase of *Erysiphe* sp. It is a plant pathogen causing powdery mildews. It is very common on the leaf's 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.

## Penicillium sp.

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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 bronchospasms; chronic cases may develop pulmonary emphysema. It may also cause headaches, vomiting, and diarrhea.

## Periconia sp.

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*Periconia* sp. are 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.

## Pithomyces sp.

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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 known to be a human allergen or pathogen. It is rarely found indoors, although it can grow on paper.

## Rusts/Smuts

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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.

## Spegazzinia

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*Spegazzinia* species comprise a very small proportion of the fungal biota. This genus is somewhat related to other lobed or ornamented genera such as *Candelabrum*. No information is available regarding health effects or toxicity. Allergenicity has not been studied. Usually identified on spore trap samples where it is seen every few weeks. (Spores have very distinctive morphology.) May also be found in air by culturable (Andersen) samples if a long enough incubation period is provided so that sporulation occurs. Our laboratory has never found this organism growing on indoor environmental surfaces. Natural habitat includes soil and many kinds of trees and plants.

## Sporotrichum

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*Sporotrichum* species comprise a very small proportion of the fungal biota and are most closely related to other colorless hyphomycetes such as *Chrysosporium*. The only information available regarding health effects are a few rare cases of repeated isolations from respiratory secretions suggestive of bronchopulmonary colonization. No information is available regarding toxicity. Allergenicity has not been studied. May be identified on surfaces by tape lifts, tease mounts from bulk samples, and in air by culturable (Andersen) samples. Many times sporulating colorless fungi are very difficult to identify, with critical structures only very faintly visible under oil immersion magnification. Thus, these isolates may be placed in the category "Colorless, sporulating, ID unknown" on the Andersen report format. Spores do not have distinctive morphology and would be categorized as "other colorless" on spore trap samples. Natural habitat includes soil and decaying wood.

## Stachybotrys sp.

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Aw - 0.94, optimum Aw  $\rightarrow$  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.**

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

### **Torula sp.**

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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.

### **Tetraploa**

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*Tetraploa* species comprise a very small proportion of the fungal biota. This genus is somewhat related to *Triposporium* and *Diplocladiella*. The only reported human infections are two cases of keratitis (1970, 1980) and one case of subcutaneous infection of the knee (1990). No information is available regarding other health effects or toxicity. Allergenicity has not been studied. Usually identified on spore trap samples where it is seen every few weeks. (Spores have very distinctive morphology.) Our laboratory has never found this organism growing on indoor environmental surfaces. Natural habitat includes leaf bases and stems just above the soil on many kinds of plants and trees.

### **Ulocladium sp.**

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

### **Zygomycetes**

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Zygomycetes are one of the four major groups of fungi, the others being the Oomycetes, the Ascomycetes, and the Basidiomycetes. Zygomycetes are common, fast growing, and often overgrow and/or inhibit other fungi nearby. *Rhizopus* and *Mucor* are two of the most common Zygomycetes seen in the indoor environment. However, others are seen as well, including *Syncephalastrum*, *Circinella*, *Mortierella*, *Mycotypha*, *Cunninghamella*, and *Choanephora*. For further information, please see descriptions of these individual genera.

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

<b>Fungi</b>	<b>Mycotoxin</b>
<i>Acremonium crocinigenum</i>	Crotocin
<i>Aspergillus favus</i>	Alfatoxin B, cyclopiazonic acid
<i>Aspergillus fumigatus</i>	Fumagilin, gliotoxin
<i>Aspergillus carneus</i>	Citrinin
<i>Aspergillus clavatus</i>	Cytochalasin, patulin
<i>Aspergillus Parasiticus</i>	Alfatoxin B
<i>Aspergillus nomius</i>	Alfatoxin B
<i>Aspergillus niger</i>	Ochratoxin A, malformin, oxalic acid
<i>Acremonium crocinigenum</i>	Crotocin
<i>Aspergillus nidulans</i>	Sterigmatocystin
<i>Aspergillus ochraceus</i>	Ochratoxin A, penicillic acid
<i>Aspergillus versicolor</i>	Sterigmatocystin, 5 ethoxysterigmatocystin
<i>Aspergillus ustus</i>	Ausdiol, austamide, austocystin, brevianamide
<i>Aspergillus terreus</i>	Citreoviridin
<i>Alternaria</i>	Alternariol, altertoxin, altenuene, altenusin, tenuazonic acid
<i>Arthrimum</i>	Nitropropionic acid
<i>Bioploaris</i>	Cytochalasin, sporidesmin, sterigmatocystin
<i>Chaetomium</i>	Chaetoglobosin A,B,C. Sterigmatocystin
<i>Cladosporium</i>	Cladosporic acid
<i>Clavipes purpurea</i>	Ergotism
<i>Cylindrocoryn</i>	Trichothecene
<i>Diplodia</i>	Diplodiatoxin
<i>Fusarium</i>	Trichothecene, zearalenone
<i>Fusarium moniliforme</i>	Fumonisin
<i>Emericella nidulans</i>	Sterigmatocystin
<i>Gliocladium</i>	Gliotoxin
<i>Memnoniella</i>	Griseofulvin, dechlorogriseofulvin, epi-dechlorogriseofulvin, trichodermin, trichodermol
<i>Myrothecium</i>	Trichothecene
<i>Paecilomyces</i>	Patulin, viriditoxin
<i>Penicillium aurantiocandidum</i>	Penicillic acid
<i>Penicillium aurantiogriseum</i>	Penicillic acid
<i>Penicillium brasilianum</i>	Penicillic acid
<i>Penicillium brevicompactum</i>	Mycophenolic acid
<i>Penicillium camemberti</i>	Cyclopiazonic acid
<i>Penicillium carneum</i>	Mycophenolic acid, Roquefortine C
<i>Penicillium crateriforme</i>	Rubratoxin

<b>Fungi</b>	<b>Mycotoxin</b>
<i>Penicillium citrinum</i>	Citrinin
<i>Penicillium commune</i>	Cyclopiazonic acid
<i>Penicillium crustosum</i>	Roquefortine C
<i>Penicillium chrysogenum</i>	Roquefortine C
<i>Penicillium discolor</i>	Chaetoglobosin C
<i>Penicillium expansum</i>	Citrinin, Roquefortine C
<i>Penicillium griseofulvum</i>	Roquefortine C, cyclopiazonic acid, griseofulvin
<i>Penicillium hirsutum</i>	Roquefortine C
<i>Penicillium hordei</i>	Roquefortine C
<i>Penicillium nordicum</i>	Ochratoxin A
<i>Penicillium paneum</i>	Roquefortine C
<i>Penicillium palitans</i>	Cyclopiazonic acid
<i>Penicillium polonicum</i>	Penicillic acid
<i>Penicillium roqueforti</i>	Roquefortine C, Mycophenolic acid
<i>Penicillium veridicatum</i>	Penicillic acid
<i>Penicillium verrucosum</i>	Citrinin, ochratoxin A
<i>Penicillium/ Aspergillus</i>	Patulin
<i>Penicillium/ Aspergillus/Alternaria</i>	Glitoxin
<i>Phomopsis</i>	Macrocyclic trichothecenes
<i>Phoma</i>	Brefeldin, cytochalasin, secalonic acid, tenuazonic acid
<i>Pithomyces</i>	Sporidesmin
<i>Rhizoctonia</i>	Slafamine
<i>Rhizopus</i>	Rhizonin
<i>Sclerotinia</i>	Furanocoumarins
<i>Stachybotrys chartarum</i>	Iso-satratoxin F, roridin E, L-2, satratoxin G & H, trichodermin, trichodermol, trichothecene
<i>Torula</i>	Cytotoxins
<i>Trichoderma</i>	Trichodermin, trichodermol, gliotoxin
<i>Trichothecium</i>	Trichothecene
<i>Wallemia</i>	Walleminol
<i>Zygosporium</i>	Cytochalasin



## General terms

### Allergen

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An allergen is a substance that elicits an IgE antibody response and is responsible for producing allergic reactions. Chemicals are released when IgE on certain cells contact an allergen. These chemicals can cause injury to surrounding tissue - the visible signs of an allergy. Only a few fungal allergens have been characterized but all fungi are thought to be potentially allergenic. Fungal allergens are proteins found in either the mycelium or spores

### "Black mold"

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A poorly defined term. Black mold or toxic black mold has usually been associated with the mold *Stachybotrys chartarum*. While there are only a few molds that are truly black, there are many that can appear black. Not all molds that appear to be black are *Stachybotrys*.

### Fungi

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Fungi are neither animals nor plants and are classified in a kingdom of their own. The Kingdom of Fungi. Fungi include a very large group of organisms, including molds, yeasts, mushrooms and puffballs. There are >100,000 accepted fungal species but current estimates range to 1.5 million species. Mycologists (people who study fungi) have grouped fungi into four large groups according to their method of reproduction.

### Hidden mold

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This refers to visible mold growth on building structures that is not easily seen, including the areas above drop ceilings, within a wall cavity (the space between the inner and outer structure of a wall), inside air handlers, or within the ducting of a heating/ventilation system.

### Microbial Volatile Organic Compounds (MVOCs)

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Fungi produce chemicals as a result of their metabolism. Some of these chemicals, MVOCs, are responsible for the characteristic moldy, musty, or earthy smell of fungi, whether mushrooms or molds. Some MVOCs are considered offensive or annoying. Specific MVOCs are thought to be characteristic of wood rot and mold growth on building materials. The human nose is very sensitive to mold odors and sometimes more so than current analytical instruments.

### Mold

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Molds are a group of organisms that belong to the Kingdom of Fungi (see Fungi). Even though the terms mold and fungi had been commonly referred to interchangeably, all molds are fungi, but not all fungi are molds.

## **Mycotoxin**

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Mycotoxins are compounds produced by some fungi that are toxic to humans or animals. By convention, the term? Mycotoxin. Excludes mushroom toxins. Fungi that produce mycotoxins are called "toxigenic fungi."

## **Spore**

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General term for a reproductive structure in fungi, bacteria and some plants. In fungi, the spore is the structure which may be used for dissemination and may be resistant to adverse environmental conditions.

## **Toxic mold**

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The term "toxic mold" has no scientific meaning since the mold itself is not toxic. The metabolic byproducts of some molds may be toxic (see mycotoxin).

## **Hypha (plural, hyphae)**

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An individual fungal thread or filament of connected cells; the thread that represents the individual parts of the fungal body.