

Techniques for Adjusting Water Intrusion Damage Claims

Effects of Mold on Human Health
What We Know
What We Don't Know

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Why Does The "Mold Problem" Now Exist?

- Not recognized at first
- Building Sciences experts too concerned with issues of energy efficiency
- Interiors became incubators
- People are spending more time inside:
Time-Weighted Exposure – Low Levels of exposure over a long period of time
- Potpourri of bio-aerosols: a thickening brew

Concern for IAQ-Incubator Effect

- 80% time spent inside homes
- ventilation reduced
- synthetic building materials
- pollutants concentrated
- time weighted exposure
- multiple pollutants-to include water
- victims are the elderly, the children, the disabled and the unsuspecting

Essentials of Healthy and Comfortable Indoor Air

- ventilation-air changes/ day
- water content of air -%RH
- comfortable even temperature
- air movement-air mixing
- all indoor air filtered
- remove pollution sources
- dilute air pollutants with ventilation

Desirable House

- Durable
- Energy Efficient
- Comfortable
- Healthy
- Good Investment
- Money flows to equity



Undesirable House

- Non-Durable
- Energy Inefficient
- Uncomfortable
- Unhealthy
- Poor Investment
- Money Flows to upkeep and maintenance



Mold-Is it a new problem?

- Mold is an essential part of our ecology
- Mold has always been with us
- Earliest reference to mold-Bible-Leviticus
- Changes in building techniques and materials main reason for the increase in moldy buildings

Molds and Fungi

- All molds are fungi
- All Fungi are not molds
- Mushrooms are classical fungi that are not molds
- Molds and other fungi grow in wet or damp environments

Mold as a Plant

- A living or growing mold is like a growing plant
- The roots are the hyphae
- The fruit are the spores
- The spores are the seeds

Mold

- What is mold?
 - ◆ Microscopic organisms that break down dead materials such as leaves, plants or other organic materials.
- How does it grow?
 - ◆ Mold needs three things to thrive:
 - ✦ moisture, nutrients, and a surface to grow
 - ◆ Mold reproduces by very tiny particles called spores.
 - ◆ If mold spores land on a suitable surface, they begin to grow.
- How does mold affect humans?
 - ◆ Mold can affect humans upon exposure.

What Causes Mold ?

- Molds are living organisms
- Their spores are seeds
- Factors necessary for mold life
 - ◆ Water
 - ◆ Nutrients
 - ◆ Temperature
 - ◆ Light

Mold-The Bottom Line

- Buildings get wet faster than they dry out
- It takes a lesser amount of water to saturate a building-decrease buffer effect
- Wood will become moldy with 20% water content
 - ◆ 1900-a 2000 sq ft house could buffer 500 gallons of water and not mold
 - ◆ 1960-a 2000 sq ft house could buffer 50 gallons
 - ◆ 2000-a 2000 sq ft house can buffer less than 10 gallons of water

Techniques and Materials

- Bulk water and vapor control
- Insulation
- Building material
 - ◆ "is wood"
 - ◆ "was wood"
 - ◆ Variations of cellulose content

Mold-The Bottom Line

- Increase water
- Decrease ventilation
- Cellulose
- Warm environment
- Mass production of molds and other bio-aerosols
- Hence we have moldy houses

The Growing Mold

- The spore lands on a patch of food or nutrient area
- It has no internal digestive system so it releases its enzymes in the area to digest the food
- A host of by products are made to include alcohols, aldehydes and many other material depending on the growing conditions

Tri-state-study



The Presence of Mold

- Mold will grow in almost any damp or wet area
- Water spots or water damage is a likely place to find mold growth
- Mold growth can be seen and will produce the “moldy smell”

Questions to Help Identify Mold Exposure

1. Has the home been flooded?
2. Is there any water-damaged wood or cardboard in the house?
3. Has there been a roof or plumbing leak?
4. Have occupants seen any mold?
5. Have occupants noticed a musty smell?

Need for Mold Assessment

- Health problems
- Property damage
- Remediation
- Completion of remediation
- Combination of above

Common Molds

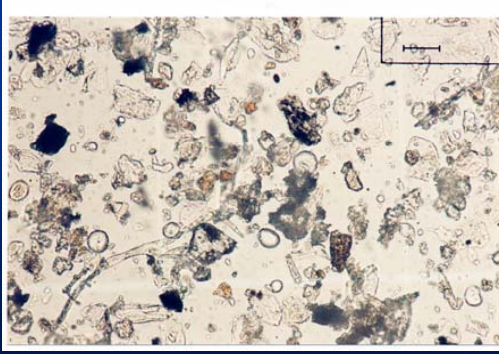
- Outdoor or plant molds
- Cladasporium
- Alternaria
- Others
- Indoor or dirt molds
- Penicillium
- Aspergillus
- Stachybotrus
- Fusarium

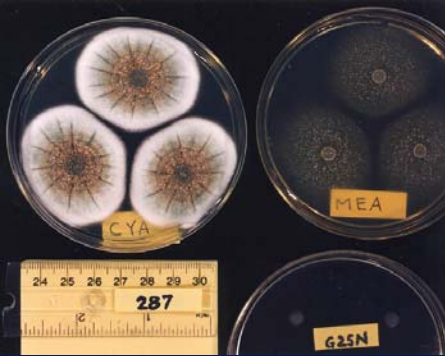
Mold Identification

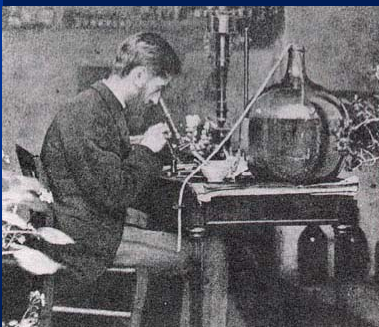
- Necessary to identify species and subspecies if there is a health problem
- If no health problem or potential problems-Use common sense
- Budget with remediation in mind
- Quantifying or identification may be necessary if there is a great concern regarding "toxic mold"

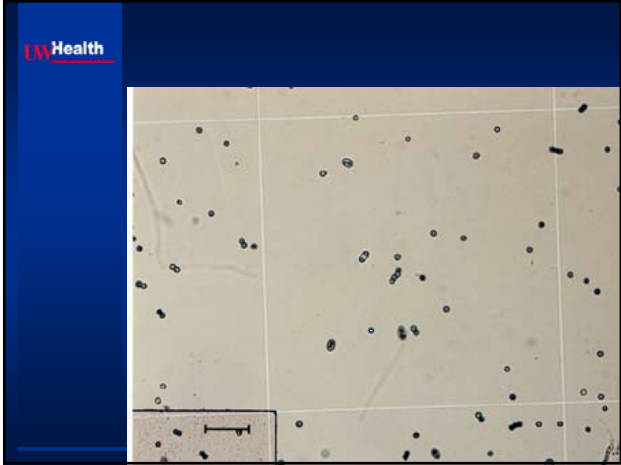
Identification of Molds

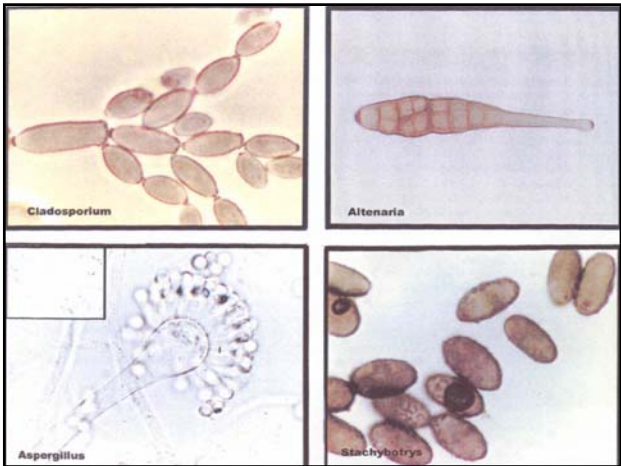
- Difficult to identify mold with the naked eye
- The object is to get a sample of the material and identify it
- Samples can be taken from the air or directly from the moldy surface
- The mycologist will use cultures ,microscopy ,PCR, and other methods to identify the mold











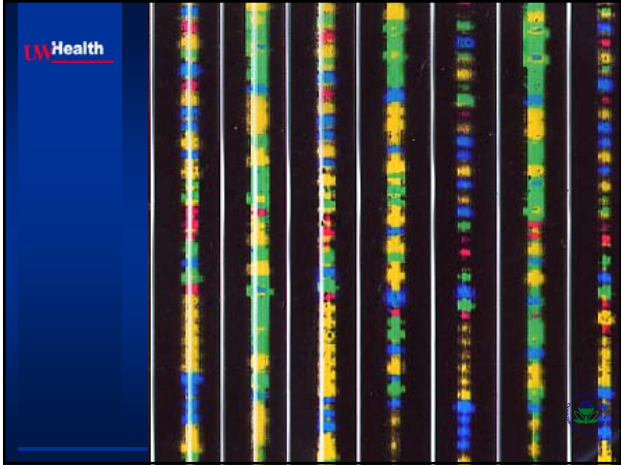


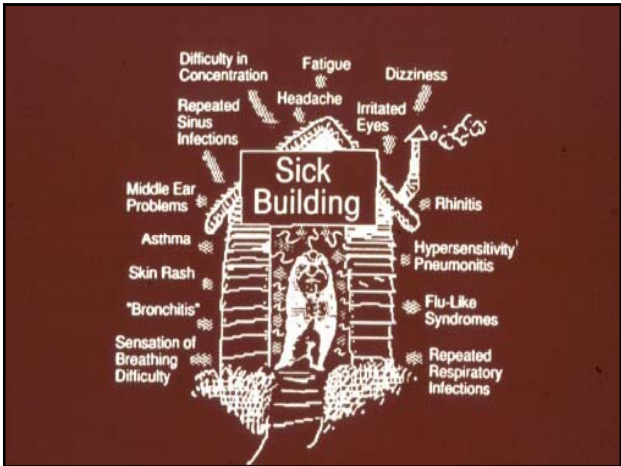




PCR-Polymerized Chain Reaction

- Newer process to identify mold classes, species and subspecies
- DNA fingerprinting
- Use of dust samples to identify molds both living and dead
- Enables the identification of the majority, if not all, of the molds that inhabited the area





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The Important Pollutants

- Bio-aerosols-Moisture driven
molds and their by-products
bacteria-endotoxin
house dust mites
- Combustion products
appliances-heaters--CO
cigarettes
- Chemicals
lead-ozone-radon-asbestos

Q: What is the Relationship between Damp/Wet Homes and Chronic Respiratory Disease?

Answer: Do a Literature Search -10 Years -Surprise!

Wet Homes	Indoor Pollution
Damp Homes	Rhinitis
Mold or Fungi	Sinusitis
Endotoxin	Asthma
Dust Mites	Respiratory Disease
Mycotoxin	Hypersensitivity pneumonitis
IAQ	VOC'S
Particulates	General Health

Water Damaged Buildings-Occupant's Symptoms

- Headache
- Postnasal drip
- Sore throat
- Fatigue
- Nasal blockage
- Green mucus
- Sneezing
- Eye symptoms
- Coughing
- Phlegm
- Irritability
- Eye burning
- Skin itching
- Clear mucus
- Watery eyes
- Nose bleeds

Water Damaged Homes-Occupant's Symptoms

- Joint pain
- Muscle pain
- Backache
- Memory problems
- Nausea
- Sleep problems

Building Related Illness (BRI)- Sick Building Syndrome (SBS)

Building related illness

- known allergic conditions
- cause and effect known
- allergic sequence
- dose response
- extended period of illness when leaving

Sick building syndrome or irritant-annoyance condition

- exact cause never found
- mixture of pollutants
- rapid relief of symptoms when leaving the building

Effects of damp and mold in the home on respiratory health

Peto, J.K.; Dickerson, J.; Li, J, European Journal of Allergy and Clinical Immunology

- Significant Asthma
 - ◆ Other respiratory diseases not studied
- Potential benefits of reducing the mold in the house have not been investigated.
- It is thought that remediation is expensive and would take a large commitment.
- This implies that houses need to be specifically designed for primary prevention of respiratory problems.
- Meta-analysis of 60 plus articles

Home dampness, current allergic diseases, and respiratory infections among young adults

M Kilpelainen, E O Terho, H Helenius, M Koskenvuo

- The risk of current asthma, allergic rhinitis, and atopic dermatitis was higher in damp homes.
- Of the respiratory infections, the risk of common colds was most clearly increased.
- 13,500 first year college students surveyed

Thorax 2001; 56:462-467

Allergenic materials in the house dust of allergy clinic patients

Barnes, Charles PhD; Tuck, Janna MD; Simon, Steven PhD; Pacheco, Freddy MS; Hu, Frank DVM; Portnoy, Jay MD

- ◆ There were measurable levels of fungal antigens (Alternaria, Cladosporium), mite antigens, and animal antigens (dog and cat) in the majority of dust samples in this self-selected set of allergy clinic patients.
- ◆ Specific allergens Alt a 1, Alt a 70kD, and Der p 1 were significantly higher in the homes of asthmatic patients when compared with patients seen for reasons other than asthma.
- ◆ **These studies support the hypothesis that fungal allergen exposure is an important component in the pathogenesis of the clinical condition known as asthma.**

Ann Allergy Asthma Immunol, Vol 86(5). May 2001.

517-523

Housing characteristics, reported mold exposure, and asthma: European Community Respiratory Health Survey

Jan-Paul Zock, PhD (J Allergy Clin Immunol 2002; 110:285-92)

- Conclusion- Indoor mold growth has an adverse effect on adult asthma
- Mold exposure was highest in older houses with recent water damage

Acute Pulmonary Hemorrhage in Infants Associated with Exposure to *Stachbotrys atra* and other Fungi

Ruth A Etzel, MD, PhD; Eduardo Montana, MD, MPH; W.G. Sorenson, PhD; Greg J Kullman, CIH, PhD; Terrance M Allan, MPH; Dorr G Dearborn, PhD, MD

- Conclusion: Infants with pulmonary hemorrhage and hemosiderosis were more likely than controls to live in home with toxigenic *S atra* and other fungi in the indoor air.

Arch Pediatr Adolesc Med, 1998;152:757-762

Case Report

A 42 year old woman moved into a reconditioned, manufactured house in 1992. The house recently had a new roof, a new subflooring and many windows replaced.

The woman and her 2 daughters had frequent URI's, medical providers visits and multiple antibiotics. None of them had significant URI's prior to moving into this house.

Special Studies:

1. RH 85%
2. 5 Indoor Molds with 2000-7000 CFU's
3. CO level of 15ppm

They moved out of the house in 1998 and since that time they have had many fewer URI's.



The four "P's of pollution

- People
- Pollutants
- Pathways
- Pressures



Medical Work up for Environmental Conditions

- History-create a time line
- health condition- pre-exposure
- health condition-exposure
- health condition-post exposure
- Physical exam
- Allergy test-vitro and in-vitro
- Imaging x-ray cat-scan
- Pulmonary function tests
- Lung biopsy - BAL exam

Environment Investigation-Interaction of the Team

- The health assessment unit
- The building inspection unit
- The Microbiologist
- The building Scientist
- DOES IT ALL FIT ????

Health Effects of Fungi

- Allergies: Susceptible People
 - ◆ Skin Rashes, Hayfever, Asthma
 - ◆ Hypersensitivity Pneumonia
- Infections: Immune Suppressed Individuals
 - ◆ Opportunistic Infection of Skin, Lungs, and Mucous Membranes
- Toxicoses: Everyone?
 - ◆ Building Related Illnesses
 - ◆ Organic Dust Toxic Syndrome

Health Effects of Fungi

- MAJOR LOWER RESPIRATORY REACTIONS
 - ◆ Organic Dust Toxic Syndrome
 - ❖ Acute, Noninfectious Flu-like Symptoms
 - ❖ Fever, Fatigue, Muscle Aches
 - ❖ Neutrophil Inflammation (Toxic Reaction)
 - ◆ Hypersensitivity Pneumonitis (Farmer's Lung)
 - ❖ Acute, Subacute or Chronic Course
 - ❖ Similar Symptoms
 - ❖ Lymphocyte Infiltration (Immune Reaction)

Mold- Mechanism of Disease

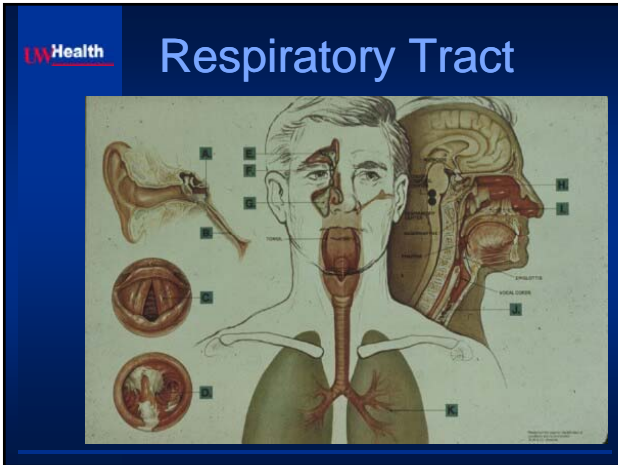
- Direct Invasion of Tissues
 - ◆ Healthy people
 - ◆ Immuno compromised people
 - ❖ HIV
 - ❖ Post Transplant
 - ❖ Cancer
 - ❖ Diabetes
 - ❖ Other
 - ◆ Direct effect of fungal components such as Beta 1-3 glucans on human respiratory tract

One Tract-One Disease- Nose to the Alveoli



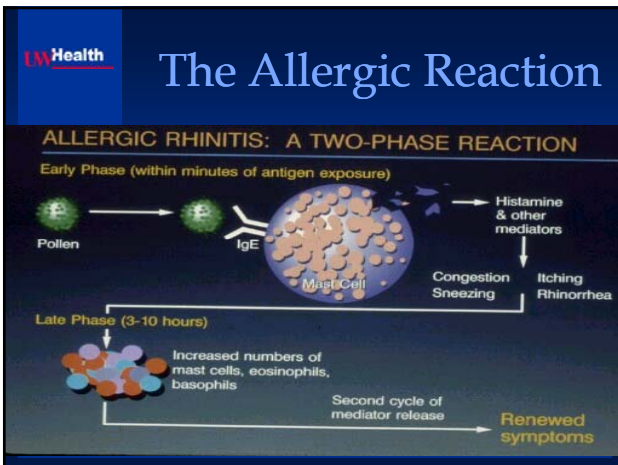
The Respiratory tract-First Line of Defense Against the World

- Most common target for environmental agents
- 8-9000 liters of air is breathed in one day
- Serves as the direct interface with the outside world
- The lungs play multiple roles
 - ◆ supplier of oxygen
 - ◆ remover of waste and toxins
 - ◆ defender against hostile intruders



Mold- Mechanism of Disease

- Classic Allergic Rhinitis and Asthma
 - ◆ IgE Antibodies to spores
 - ◆ IgE Antibodies to mold proteases
 - ◆ Other
- Allergic Fungal Sinusitis
- Allergic Broncho-Pulmonary Aspergillosis (ABPA)



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Asthma

Asthma: A Lung Disease with Airway...

- Obstruction (at least partially reversible)
- Hyperreactivity
- Inflammation

Normal Bronchiole

Asthma

- Mast cells
- Bronchospasm
- Edema (and mucus)
- Eosinophils
- Lymphocytes

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Asthma

PRECIPITATING OR AGGRAVATING FACTORS

ASTHMA PATIENT

- viral respiratory infections
- exercise
- endocrine factors
- drugs: aspirin, beta blockers
- weather changes: cold air
- allergens
- emotional expression: anger, laughing
- food additives: sulfites
- environmental changes
- exposure to irritants and occupational chemicals

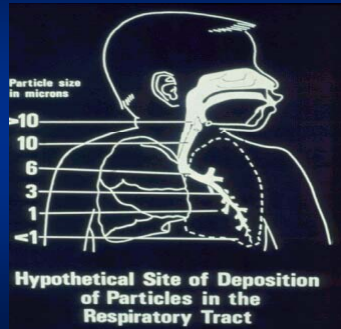
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Bronchial Tubes and Alveoli

Bronchioles

Alveoli

Particulate Movement in the Tracheobronchial Tree



Hypersensitivity Pneumonitis- Allergic Alveolitis

- Inflammation of the air sacs or alveoli
- Caused by a host of fungal bioaerosols
- Materials penetrate deep into the lungs- smaller particles
- IgG antibody identified by diffusion type of reaction
- Will become a disabling disease if subject is not totally removed from the antigen source

Innate immunity

- Direct effect of a biological material
 - ◆ glucans
 - ◆ proteases
 - ◆ endotoxin
 - ◆ DNA from bacteria
 - ◆ gram positive bacteria products

Fungi or Molds

- Provoke illness
 - ◆ Direct invasion of tissues
 - ◆ Allergic reactions
 - ◆ Irritation or innate immunity
 - ◆ Toxic reactions to cells or tissues

Molds and Fungi

- Irritative or Innate Reactions
- Not so well known-but gradually becoming understood
- The reaction from the combination of mold products
- Responsible for the inflammation of the reparatory membrane caused by the mold exposure when the allergy test are negative
- Probably responsible for the increased number of respiratory tract infections

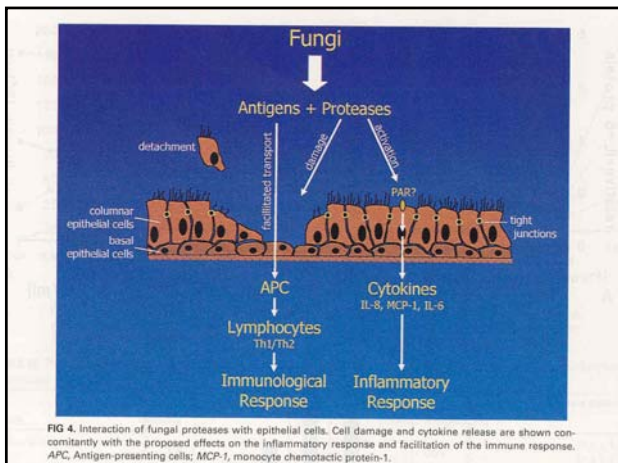


FIG 4. Interaction of fungal proteases with epithelial cells. Cell damage and cytokine release are shown concomitantly with the proposed effects on the inflammatory response and facilitation of the immune response. APC, Antigen-presenting cells; MCP-1, monocyte chemoattractant protein-1.

Molds and Fungi

- Toxic reactions are the least well understood
- The term "Toxic Mold" has caused needless hysteria
- Nevertheless -People have been harmed with mycotoxins
- Mold toxin or mycotoxins have a great potential for damaging or killing cells or tissues

Molds and Fungi

- Food and veterinary science has taught most of what we know about the effect of mycotoxins on living animals
- St Anthony's Fire is a good example of a well known human disease
- Molds produce a variety of mycotoxins that can have a variety of effects on living cells and tissues-can be very subspecies specific
- Polymerized chain reaction (PCR) has taught much in regards to subspecies specificity of mycotoxin production

Mycotoxins

Mycotoxin - fungal product that results in a deleterious short-term or long-term effect in a host.

Most describes mycotoxins are "secondary metabolites" - low-molecular-weight byproducts of fungal metabolism required for growth of the fungus .

Mold-Mechanism of Disease

- Mycotoxins
 - ◆ Mycotoxins are metabolites of active growing molds
 - ◆ Wide spread effect on many tissues
 - ◆ These toxins can be: nephrotoxic, hepatotoxic, neurotoxic, and effect other organ system

Distinctions between fungal toxins and allergens

Toxins

- Damage is mediated by toxic activity of fungal product.
- No prior exposure required
- Host damage typically requires hours or days (acute) - years (chronic) to develop.
- Usually low-molecular-weight secondary metabolites.

Allergens

- Damage is mediated by host response to fungal component.
- Prior exposure required for sensitization.
- Host damage occurs rapidly (presuming the prior, sensitizing exposure).
- Usually allergens in high molecular-weight glycoproteins.

Toxicity of Mycotoxins

Cellular

- Cytotoxic
- Inflammatory
- Immunosuppressive
- Mutagenic
- Carcinogenic
- Teratogenic
- Genotoxic

Organ Systems

- Neurotoxic
- Pulmonary Toxic
- Dermally Toxic
- Gastrointestinal Toxic
- Hepatotoxic
- Nephrotoxic

Selected mycotoxins

- Aflatoxins- - - - Turkey X disease
- Ergots- - - - - St Anthony's Fire
- Trichothecenes- - - Irritation of mucous membranes
- Deoxynivalenol - anorexia, vomiting (DON, vomitoxin)
- Fumonisin - - - - equine leukoencephalomalacia
- Zearaleone - - - - estrogenic effects
- Ochratoxins - - - - nephrotoxic hepatotoxic immunosuppressive

Selected Mycotoxins and Their Effects

Mycotoxin	Primary Health Effect	Fungi Producing
Alfatoxins	Carcinogen Hepatotoxin	Aspergillus flavus Aspergillus parasiticus
Ergot alkaloids	Ergotism	Claviceps purpurea
Fumonisin	Carcinogen Neurotoxin	Fusarium moniliforme Fusarium proliferatum Aspergillus ochraceus
Trichothecenes Macrocyelic Satratoxins	Protein Synthesis Inhibition Hemorrhage	Stachybotrys chartarum

Selected Mycotoxins and Their Effects

Mycotoxin	Primary Health Effect	Fungi Producing
Nonmacrocyelic Deoxynivalenol	Emesis	Fusarium cerealis Fusarium culmorum
T2 Toxin	Hemorrhage Emesis	Fusarium sporotrichioides

Summary of Diseases from Wet Buildings

- Chronic rhinitis and sinusitis often with nose bleeds
- Frequent respiratory infections
- Headaches, malaise and/or low-grade fever
- Allergic rhinitis and asthma
- Hypersensitivity pneumonitis
- Organic dust syndrome

Summary of Wet Building Diseases

- Suspected but not yet scientifically established
 - ◆ Mycotoxin effects on brain function
 - ◆ Mycotoxin effects on the digestive tract function
 - ◆ Endotoxin-induced COPD
 - ◆ Hemorrhagic lung condition in infants

IAQ and Human Toxicosis: Empirical Evidence and Theory- Harriet M. Ammann, PhD

- Field exposures more complex than laboratory animal exposures to single pollutants
- Low levels in the field are confounded by multiple factors
- Differences in host immunity and susceptibility
- Heterogeneous host populations
- Additive or synergistic effects of pollutants
- Very difficult to prove anything for certain
- The definitive study will be huge and expensive
