Mold, Moisture and Air Quality

Maine Center for Disease Control and Prevention
An Office of the Department of Health and Human Services
Paul R. LePage, Governor
Mary C. Mayhew, Commissioner

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Content Sources

Federal Emergency Management Agency

Rutgers University Libraries Collection Management and Preservation Groups Updated March 2011

U.S. Environmental Protection Agency

U.S. Department of Health and Human Services/ Center for Disease Control and Prevention

International Environmental Technology and Training Center

Operating Engineers National Hazmat Program

About this training

Intended Audience

Local Health Officers, code enforcement officers, building inspectors, who are responsible for observing and reporting building-related problems.

Completion Requirement

Maine CDC may make completion of this course mandatory. Otherwise, completion of this training can be used for continuing education credit hours.

Purpose and Scope

This course is designed to help LHO/CEO understand:

- Why and how mold grows inside buildings, and...
- The role of tenants and property owners in preventing that growth

Training Outline

The course contains ---- and is divided into 8 sections. It will take approximately _____to complete the content and knowledge check.

1. **What are molds? Why the concern ?**

Tenants
Homeowners
Property owners

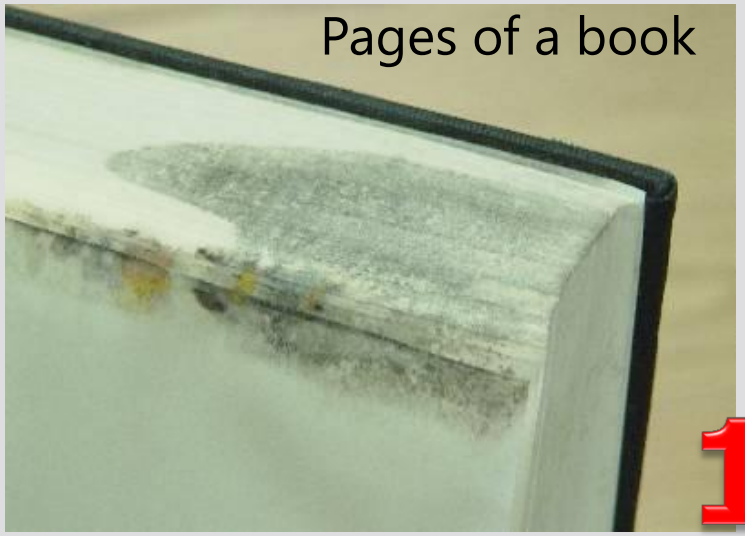
2. **When and How Mold grows ?**
3. **When is a mold problem solved?**
4. **Roles in preventing mold**

Reporting building – related health effects

5. **Warning signs of mold**
6. **Reporting mold and moisture problems**
7. **^^^^^**

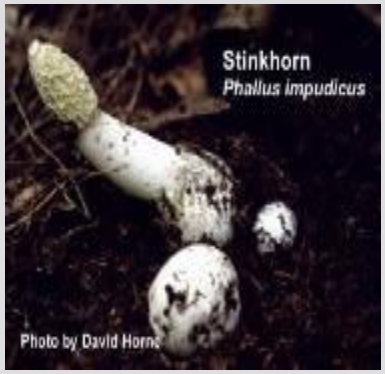
Recognizing Mold

Recognizing Mold



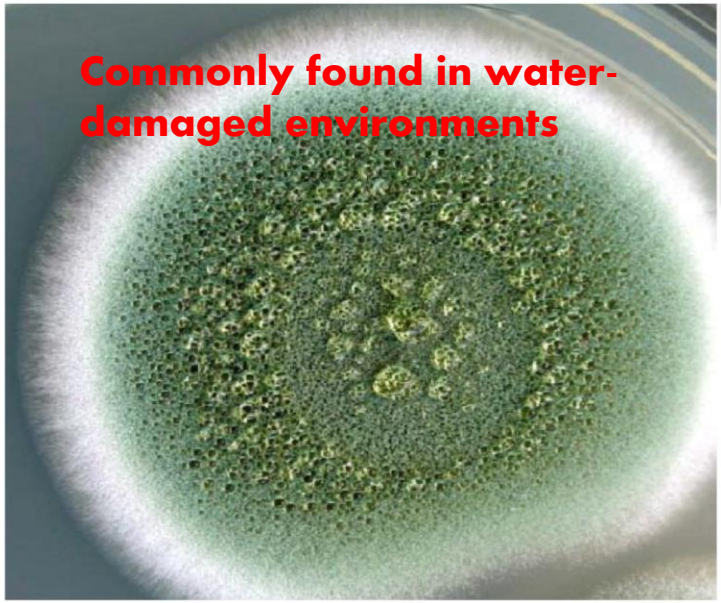
Mold **growth** in a petrie dish

What are these?



Truffles

Common Fungi



***Penicillium chrysogenum* in culture**

A culture of Aspergillus ochraceus

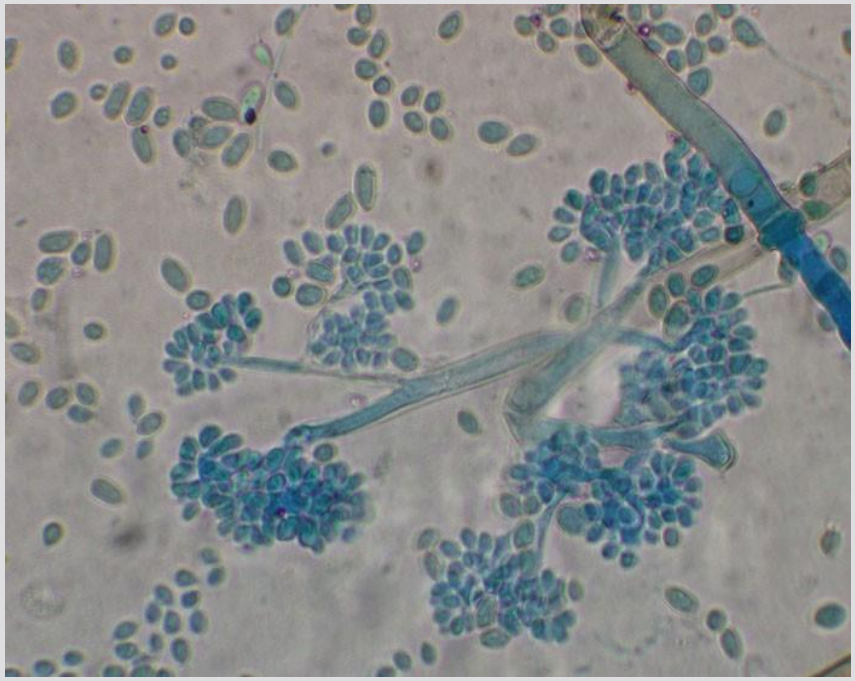
Recognizing Mold

Dormant Mold

Active Mold

Bread

What is mold?



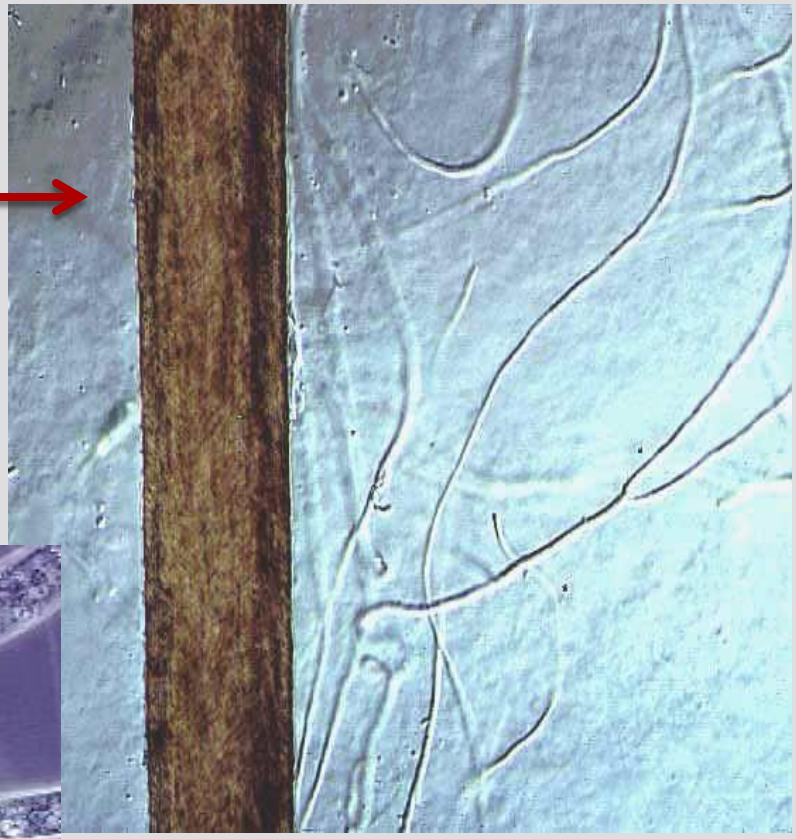
Mold is a type of fungus. It spreads by releasing spores into the air. Under the right conditions these spores bloom and mold grows.

Mold needs food in order to survive and can eat almost any organic materials – including books, clothing, sheet rock.

Hyphae Size

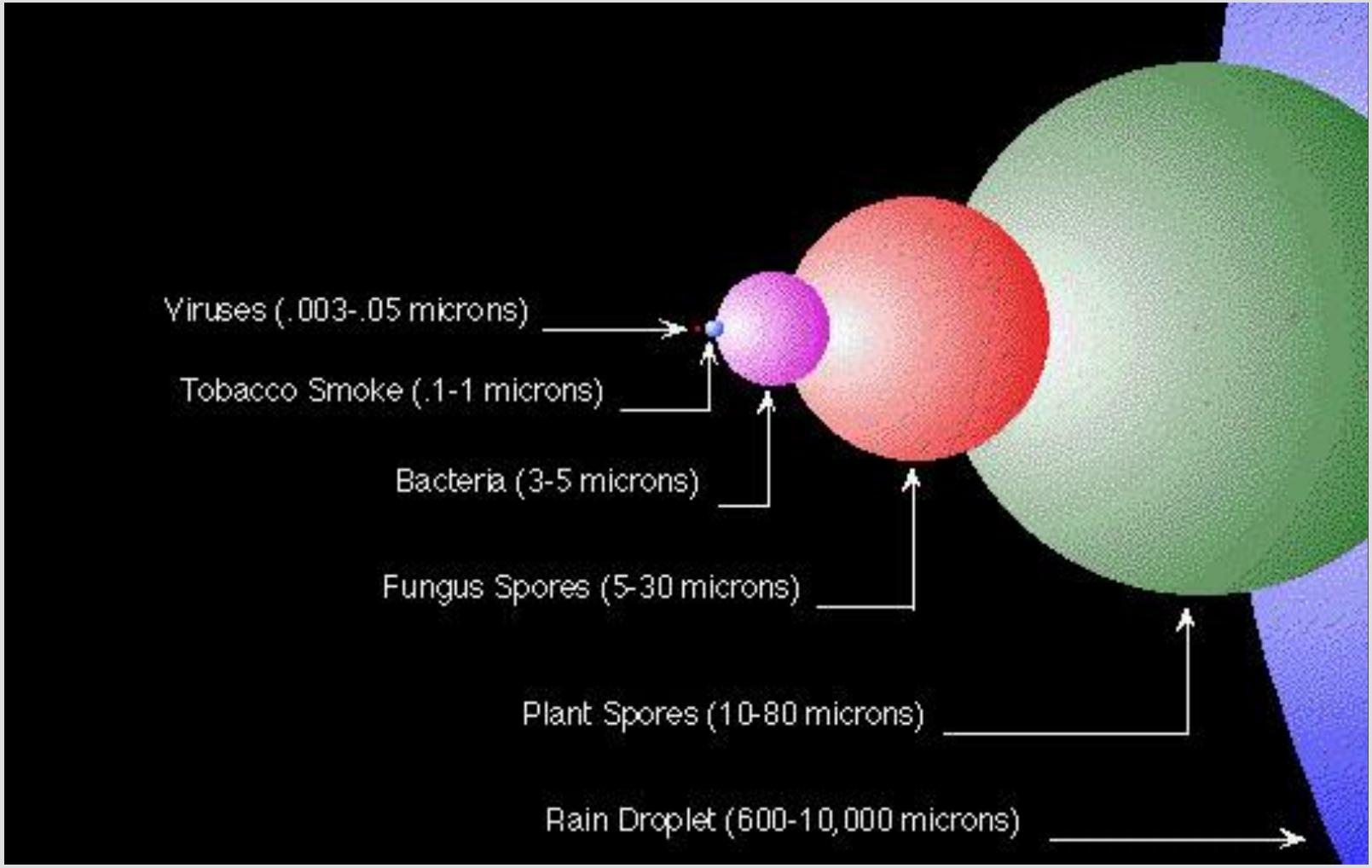
- Hair 100 microns

- Hyphae belong to the genus *Penicillium* and they are about 2-4 microns across



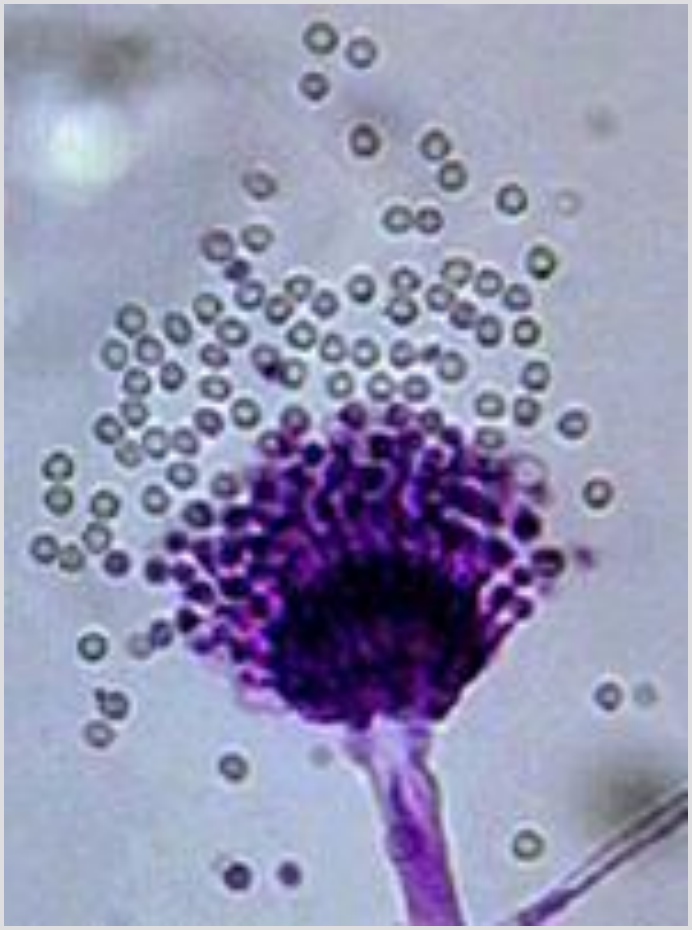
Hyphae of the water mold *Saprolegnia*

Relative size scale



Spore Size

- Outdoor air normally always contains some level of these airborne mold spores
- Hundreds or even thousands of mold spores per cubic foot of outdoor air
- Dry, maintained carpet typically contains at least 100,000 mold spores per gram of carpet dust



Light Microscope Image of *Aspergillus* Spores

Spore Size - Puffball

- Most molds reproduce by forming spores that disperse into the air in search of more food and moisture (similar to seed dispersal from plants)
- Millions of spores being released into the atmosphere from a puffball
- Most filamentous mold spores are microscopic and therefore, invisible to the naked eye

- To work on
  - “Prevention is important to avoid mold problems.”

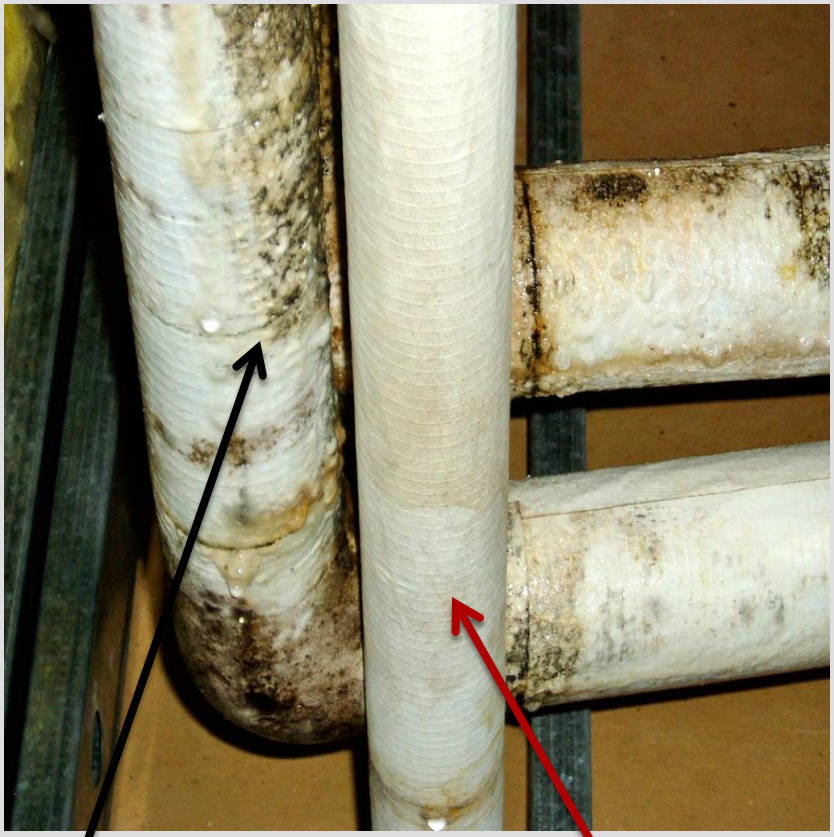
When and how mold grows

Mold only grows on damp materials

Without damp material, mold cannot grow. So if the building and it's furnishings stay dry, mold will not grow.

But when things get wet and stay that way... mold will definitely grow, given enough time.

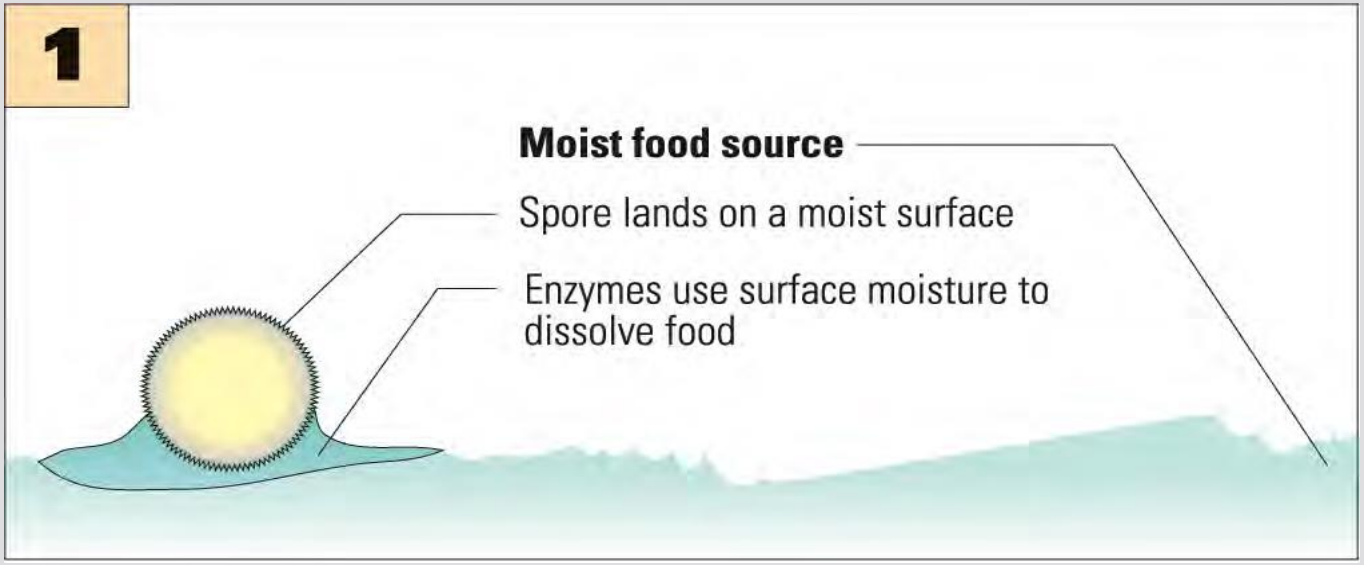
It's that simple.



What Does Mold Need to Grow?

- **Can grow at temperatures as low as -70° C and over 50° C**
- **Most thrive at between 18 - 32° C**
- **Need moisture, food source, and amiable temperature**

Mold Growth (Step 1 of 4)

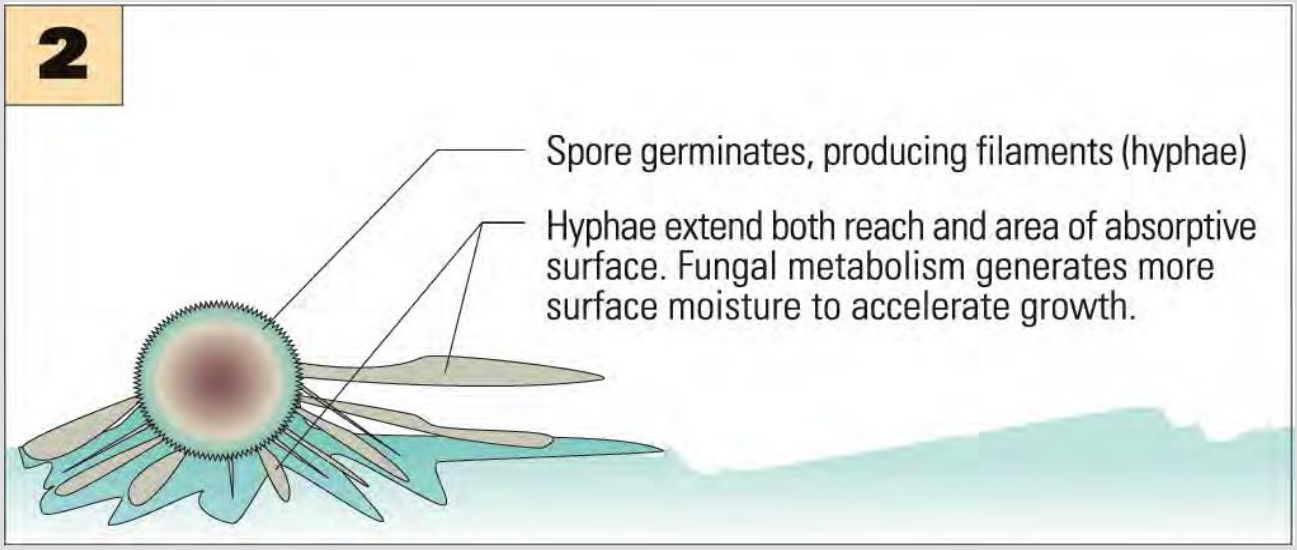


Mold growth starts on a damp food source

When a spore lands on a damp food source, the enzymes on the spore's surface react with the damp food, breaking it down into a kind of "soup of nutrients."

Slowly, that nutrient soup is pulled into the spore, sucked in by the dry material inside the spore.

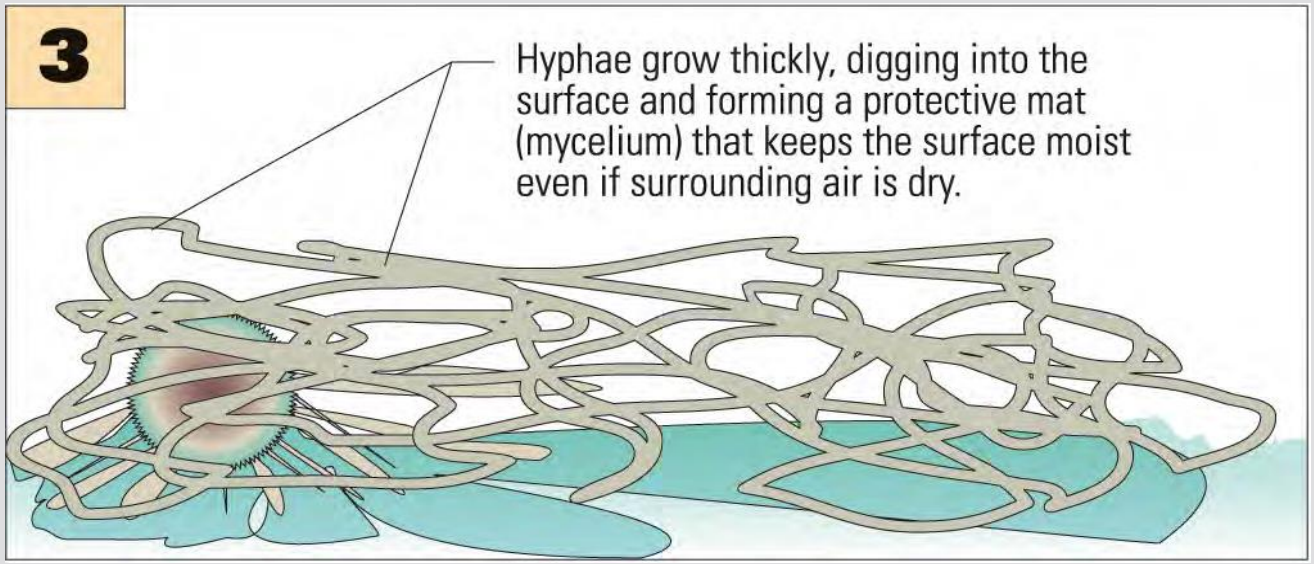
Mold growth (Step 2 of 4)



Given nutrients, the spore germinates

After the nutrient soup is pulled into the spore, the fungus has the resources it needs to germinate and grow. Unlike plants, fungus does not need sunlight—it just needs damp food. The filaments which grow out of the spore also have enzymes on their surfaces. So they can help dissolve more of the damp food and absorb its nutrients, accelerating the mold growth.

Mold growth (Step 3 of 4)

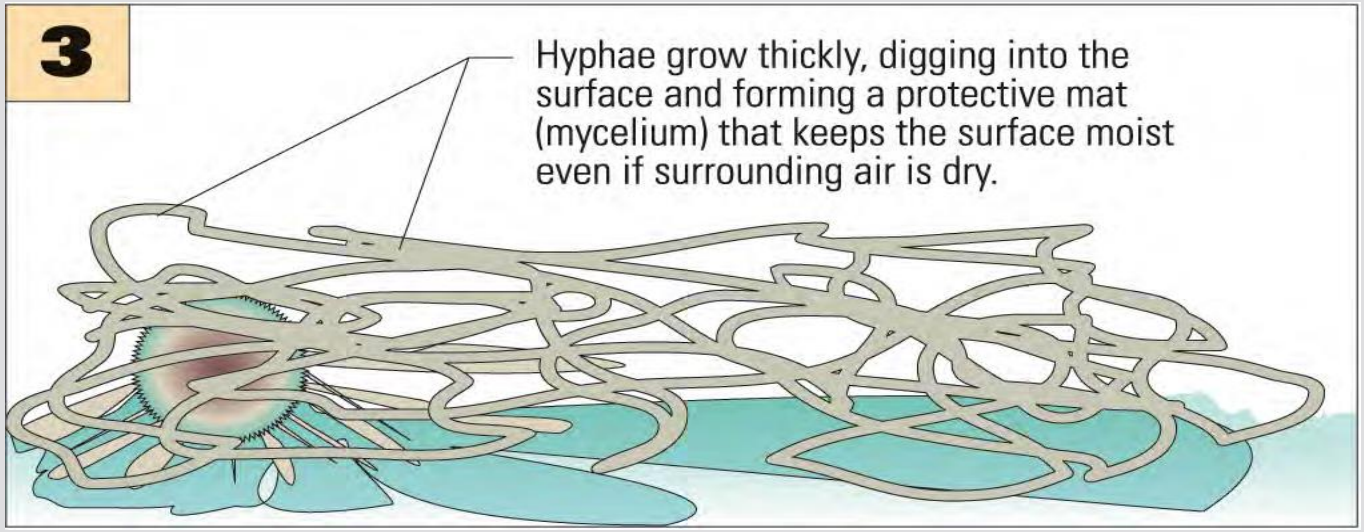


Growth speeds up as available water increases

The filaments grow thicker, extending the reach of the fungus over any food source which is damp enough to dissolve.

All that fungal chow time generates additional water—just like human metabolism generates water in the form of urine. The metabolic water helps the fungus dissolve even more of the food source—so the fungus grows faster.

Mold growth (Step 3 of 4)



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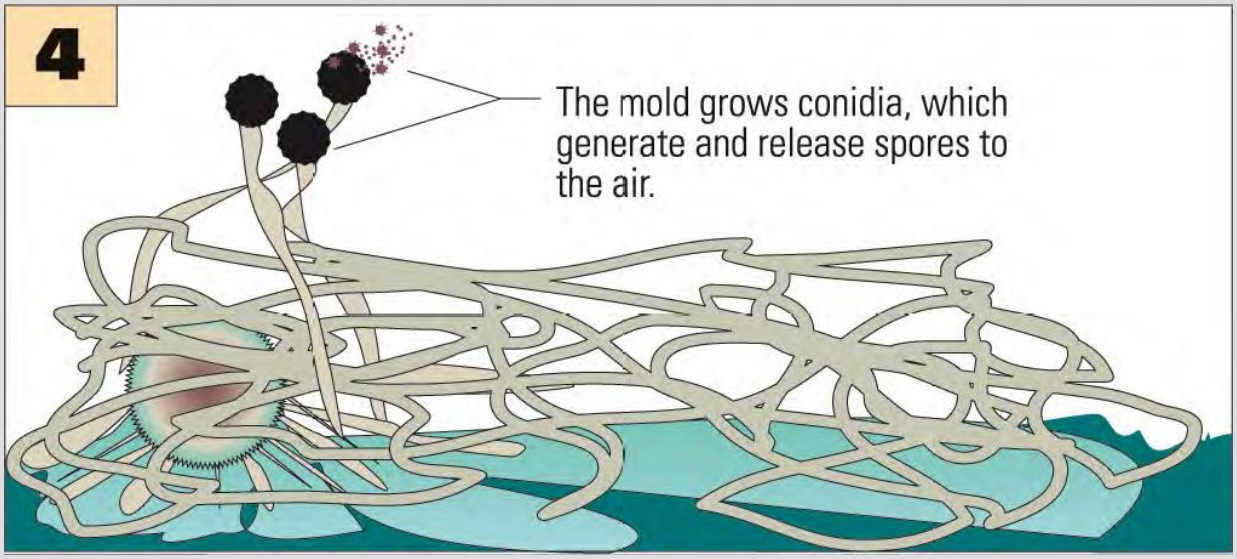
Mold growth (Step 4 of 4)



Growth stops when food dries out

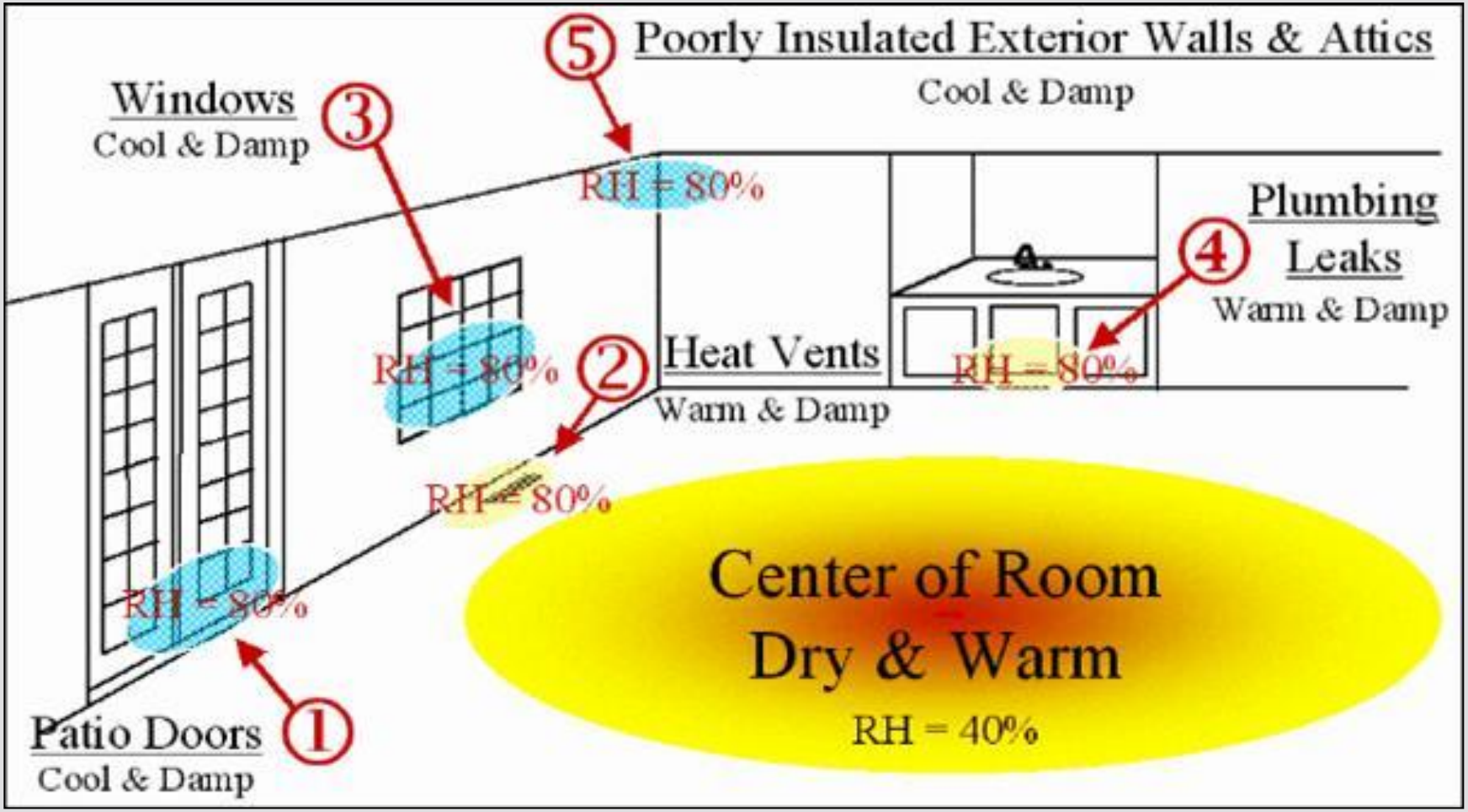
Growth slows or stops entirely when the food source runs out, or when it dries up enough to keep the fungus from dissolving it. At that point, the fungus often puts its efforts into reproduction, generating billions more spores which drift off into the air. These land on other damp food sources, where the fungus can grow again.

Why is mold a problem

Mold damages buildings and it's furnishings

Mold breaks down fabrics and paper-based materials such as the paper facing of gypsum wall board and acoustic ceiling tile.

Relative Humidity



Why be concerned about uncontrolled moisture in buildings:

Mold actively growing indoors may:

- degrade the surrounding materials,
- weaken the structure, and
- add unhealthy fungal products and bioaerosols to the indoor air.

When mold is growing other agents are likely present:

- dust mites,
- Bacteria and their products
- other animal proteins such as cockroach droppings and pet animal dander

Slide adapted from presentation by *Paula Schenck, MPH, UCONN Health Center*

Buildings and Mold

Just Add Water and They Grow!

Mold growing on the ceiling.

Why care about mold in Buildings

Mold can eventually lead to heath problems

- Mold only grows in damp material. And when an entire building is damp, chances are good that its occupants will have a higher percentage of health problems than occupants of dry buildings.

Mold looks and smells awful

- Mold growth is disgusting to look at and to smell. It's difficult to be productive and do high-quality work in a moldy building... And it's very annoying to live in one.

Slide adapted from presentation by Paula Schenck, MPH, UCONN Health Center

Mold in buildings

- Mold have found a great climate and plenty to eat in buildings
- Almost no competition or predators
- Really are a natural part of the building
- Some types are very common indoors, e.g., Cladosporium, stachybotrys, Penicillium, Aspergillus

Mold in buildings

Dry rot fungus growing in a house

Mold Contamination

- Presence of active growth (past or current) of mold can impact your health
- Airborne mold can be inhaled

How damp is *damp*

- Mold growth rates depend on the material as well as it's moisture content.
- As one example, consider what happens in a damp basement. Mold grows on paper or fabrics before it grows on the wooden structure of the building.
- Basically, the wetter and more "chopped-up or pre-cooked" any food source is, the easier it is for the fungus to dissolve it.

More dampness = more mold

When will I know when a mold problem is fixed?

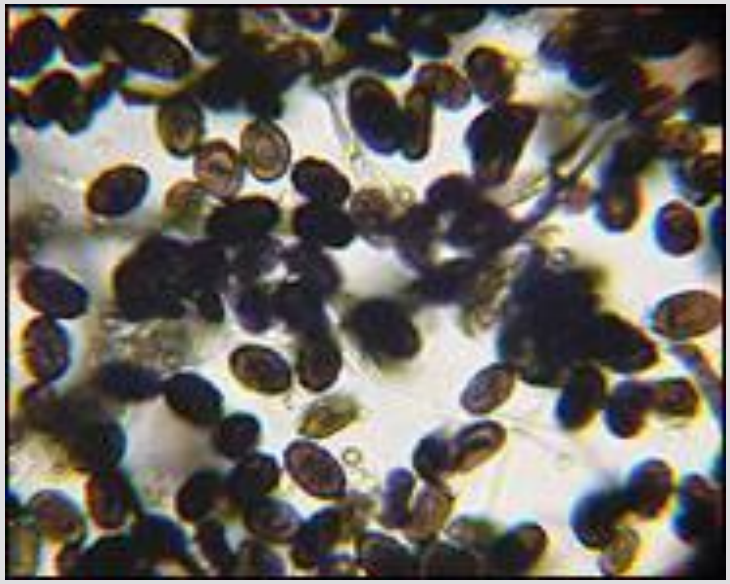
A mold problem is fixed when:

1. All the mold has been removed.
2. Any remaining damp material has been dried out or replaced.
3. The problem which led to the moisture accumulation is understood, defined and fixed.

Fix the Leak

Mold is Gold

- No established exposure limits
- No mandated training requirements
- No established clearance criteria
- Public concern/fear
- Fungi Versus Asbestos
  - Fungi is living
  - Spore can regenerate



Mycotoxins

- Fungi that produce mycotoxins are referred to as toxigenic fungi
  - Aspergillus
  - Fusarium
  - Penicillium
  - Stachybotrys
  - Myrothecium
- Fungi that produce potent mycotoxins
  - Seldom abundant in outdoor ambient air.
  - Most toxic exposures occur from indoor growth of fungi related to excessive moisture

Health Risks

People with allergies to mold may get:

- Watery eyes
- Runny or stuffed noses
- Itching
- Headaches
- Difficulty breathing
- Mold can also trigger asthma attacks

Prevention

What can you do? To prevent and get rid of mold:

- Keep your house clean and dry.
- Fix water problems such as roof leaks, wet basements, and leaking pipes or faucets.
- Make sure your home is well ventilated and always use ventilation fans in bathrooms and kitchens.
- If possible, keep humidity in your house below 50% by using an air conditioner or dehumidifier.
- Avoid using carpeting in areas of the home that may become wet, such as kitchens, bathrooms and basements.
- Dry floor mats regularly.

WARNING:

BLEACH SHOULD NEVER BE MIXED WITH OTHER CHEMICALS UNLESS THE PRODUCT LABEL INDICATES IT IS SAFE. BLEACH SHOULD NEVER BE COMBINED WITH ANY AMMONIA-CONTAINING PRODUCT BECAUSE CHLORINE GAS WILL FORM.

Always provide proper ventilation when using chemical cleaners and disinfectants. Users must wear protective gloves when using bleach solutions to avoid skin burns.

- The best way to identify a mold problem is to conduct a visual inspection and moisture investigation to identify the moisture sources.

Some common moisture sources are:

Indoors

- Humidifiers
- Cooking and dishwashing
- Bathing / Showering
- Plumbing / Roof leaks
- House plants
- Firewood stored inside
- Unvented clothes dryer/indoor clothes line
- Improper venting of combustion appliances
- Occupancy load

Outdoors

- Flooding
- Rain or snowmelt
- Seasonal high humidity
- Ground moisture
- Wet building materials

Dangerous v. Safe mold

Mold is always a warning sign of a problem
When mold is growing, it means there's a problem, or there will be a problem in the near future.

Mold is rarely toxic enough to cause problems in healthy adults.
But some fungi can produce toxic Substances (antibiotics), which protect their food sources from competing bacteria

So you don't want to inhale mold particles. And you don't want to eat the molds that grow in a building the way you'd eat the harmless and tasty mold in blue cheese.

Don't panic when you see or smell mold indoors—but don't ignore it either. There's no point wasting time worrying about which sort of mold is growing. If you see mold or smell it in a building... it's a problem and it must be removed.

You Can Control Mold

Inside your home you can control mold growth by:

- **Controlling humidity levels;**
- **Promptly fixing leaky roofs, windows, and pipes;**
- **Thoroughly cleaning and drying after flooding;**
- **Ventilating shower, laundry, and cooking areas.**

Control Moisture Problems and Mold:

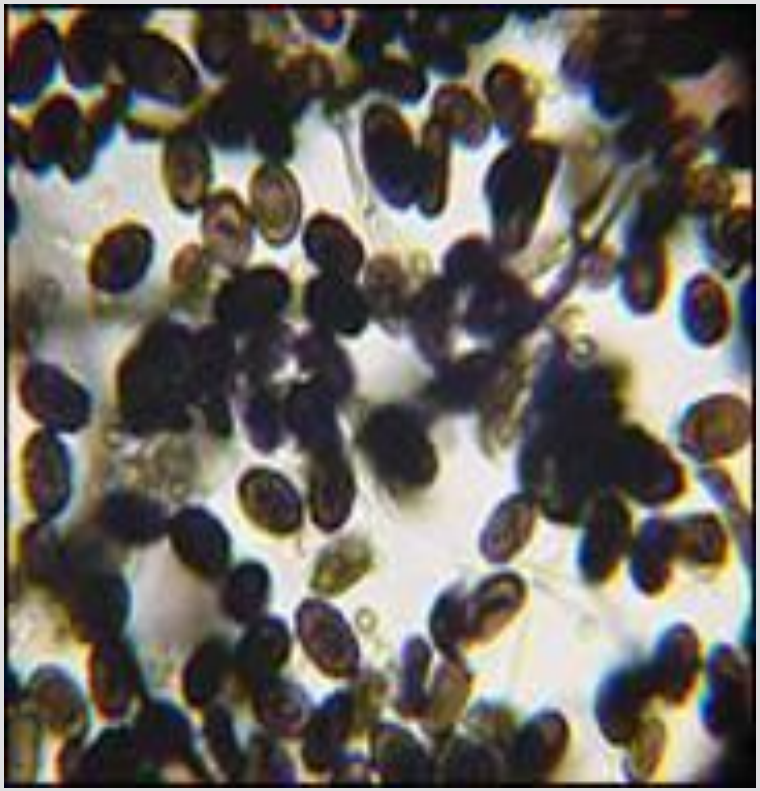
- Fix any water problems immediately and clean or remove wet materials, furnishings or mold.
- Clean up spills or floods within one day. If practical, take furniture that has been wet outside to dry and clean. Direct sunlight prevents mold growth.
- Dry all surfaces and fix the problem or leak to prevent further damage.
- Install a dehumidifier when a moisture problem is evident or when the humidity is high.

To find mold that might be growing in your home:

- Search for moisture in areas that have a damp or moldy smell, especially in basements, kitchens and bathrooms.
- Look for water stains or colored, fuzzy growth on and around ceilings, walls, floors, windowsills and pipes.
- If you smell a musty odor, search behind and underneath materials such as carpeting, furniture or stored items.
- Inspect kitchens, bathrooms and basements for standing water, water stains and patches of out-of-place color.

How do I know what mold I have?

- Bluish-green to green
  - Penicillium
  - Aspergillus
- Black to brown-black
  - Aspergillus niger
  - Alternaria alternata
  - Cladosporium herbarum
  - Cladosporium sphaerospermum
  - Stachybotrys chartarum
- Reddish or pink
  - Fusarium



Common Fungi

- Cladosporium
- Penicillium
- Alternaria
- Aspergillus

Penicillium chrysogenum

Aspergillus ochraceus

Killer Black Mold?

- Stachybotrys chartarum
- 35% of the isolates from buildings produce
  - SUPER TOXIC cytotoxic mycotoxins and satratoxins.

Recognizing Mold

Mold exists in two states: active and dormant. Active mold is eating, growing and producing spores. Dormant mold is inactive but may reactivate if the conditions are right. For library staff, it is difficult to determine if mold is active or dormant

Recognizing Mold

Active Mold

The mold on this bread is active mold. The mold is alive and currently producing spores. Sometimes active mold can appear powdery, like on this bread. Other times it may appear damp and slimy.

Sufficient Evidence of an Association between Exposure and Following Illnesses:

- Development of asthma (WHO)
- Exacerbation of asthma (IOM, WHO)
- Current asthma (WHO)
- Hypersensitivity pneumonitis (IOM, WHO)
- Respiratory infections (WHO)
- Cough, wheeze, and dyspnea (IOM, WHO)
- Upper respiratory symptoms (IOM, WHO)

(WHO: World Health Organization; IOM: Institute of Medicine)

Slide adapted from presentation by Ju-Hyeong Park, ScD, MPH, CIH and Michelle R. Martin, MS; MIAQC Annual Conference 2011

NIOSH Dampness & Mold Assessment Form (One sheet per room)

Date:_____ **Observer:**_____ **Building:**_____ **Wing:**_____ **Floor:**_____ **Room Number:**_____

Room Type: *Fill in the bubble for the type of room you are assessing.*

○ Classroom ○ Office ○ Hallway ○ Conference room ○ Bathroom ○ Custodial closet ○ Mechanical room ○ Storage
○ Library ○ Cafeteria ○ Gym ○ Auditorium ○ Kitchen ○ Locker room
○ Entrance area ○ Stairwell ○ Other _____

MOLD ODOR: ***Be sure to smell for mold odor when you first walk into the room/area.*** **Fill in the appropriate bubble.**

⓪ NONE ① MILD ② MODERATE ③ HEAVY **Source of MOLD ODOR?** _____ ○ Source Unknown

Fill in bubbles for each column and row.	*NA Mark "X"	DAMAGE or STAINS 0 1 2 3	VISIBLE MOLD 0 1 2 3	WET or DAMP 0 1 2 3	Row Totals	NOTES
Ceiling		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Walls		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Windows		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Floors		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
HVAC systems		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Pipes		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Furnishings		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Supplies & Materials		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Other_____		⓪ ① ② ③	⓪ ① ② ③	⓪ ① ② ③		
Column Totals						
Column Averages						

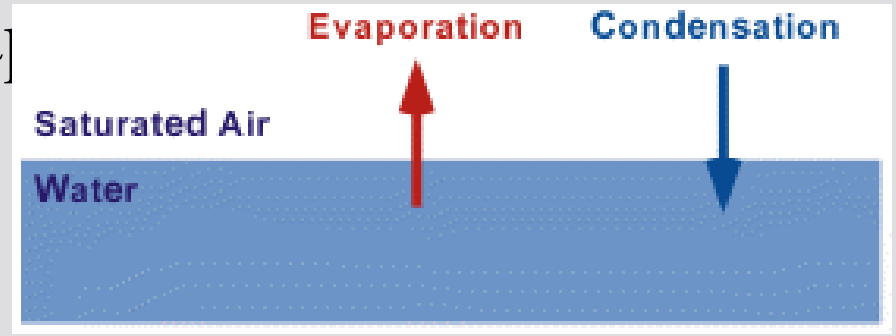
Size based scores➔ 0 = NONE 1 = size of this form or smaller 2 = larger than this form, smaller than the size of a standard interior door 3 = larger than the size of a standard interior door

*NA = Not Applicable

Thank you for viewing this mold training tutorial

Relative Humidity

- The amount of water vapor in the air at any given time is usually less than that required to saturate the air.
- The relative humidity is the percent of saturation humidity, generally calculated in relation to saturated va



Aflatoxin

Aspergillus flavus

- Food products contaminated with aflatoxins
  - Cereal (maize, sorghum, pearl millet, rice, wheat)
  - Oilseeds (groundnut, soybean, sunflower, cotton)
  - Spices (chillies, black pepper, coriander, turmeric, zinger)
  - Tree nuts (almonds, pistachio, walnuts, coconut)
  - Milk.
- Contamination costs US producers more than $100 million per year on average
- $ 26 millions to peanuts ($69.34/ha)
- Animals that have consumed feed contaminated with aflatoxins