

# Mold and Indoor Air Quality in Sensitive Environments

Nebraska Extension



# Indoor Air Quality (IAQ)

- ❖ Air quality can be affected by many compounds and organisms
- ❖ Molds and other indoor air pollutants can have negative effects on occupants' health
- ❖ Some indoor air pollutants can be triggers for asthma
  - A lung disease that, when triggered, can result in severe, acute attacks that can be life threatening

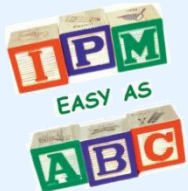


# GEO Report...

- ❖ Over 50% of the nation's schools have poor ventilation and significant sources of pollution in buildings



Photo: USDA



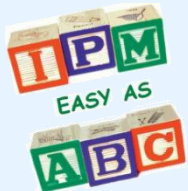
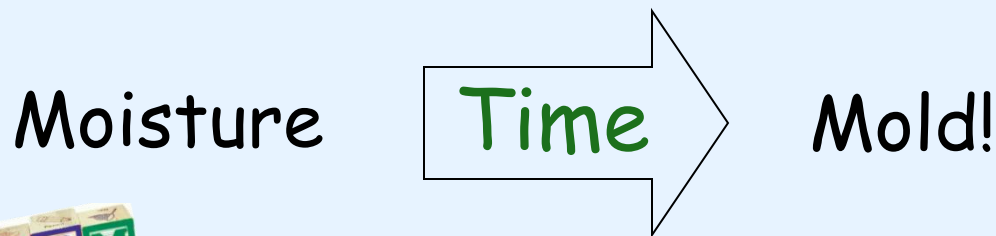
# Factors Affecting IAQ

- ❖ Tighter building construction or remodeling of old structures
  - Energy efficient practices without adequate ventilation and humidity control
- ❖ Synthetic building materials and furnishings
- ❖ Chemical products used indoors
  - Some give off Volatile Organic Compounds (VOCs)
- ❖ Pests - Cockroaches, rodents
- ❖ Dust mites and other components of dust
- ❖ Animals - classroom pets



# Factors Affecting IAQ

- ❖ Pollen
- ❖ Secondhand smoke and combustion
- ❖ High humidity, condensation, leaking roofs (and other parts of buildings) cause moisture problems when food (organic matter) and other conditions are present



# Leaking Roofs and Buildings Allow Entry of:

- ❖ Moisture
- ❖ Insects
- ❖ Rodents
- ❖ Organic materials (i.e. soil)
- ❖ Pollutants

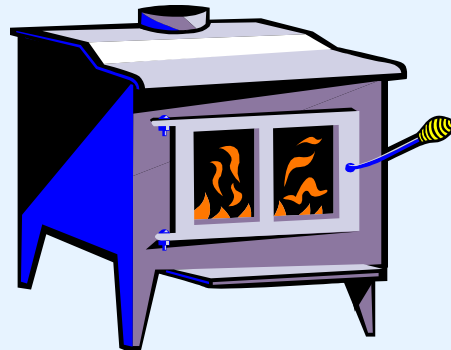


Photo: University of Nebraska–Lincoln



# Potential Air Pollution Sources

- ❖ Inadequately vented gas appliances
- ❖ Formaldehyde from new building products
- ❖ Other products, including pesticides





# Health Consequences of Poor Indoor Air Quality

## ❖ Short-term health effects of pollutants:

- Asthma and wheezing attacks
- Sinus congestion, sneezing, nose itching, coughing
- Headache, fatigue, and shortness of breath
- Eye, nose, throat, and skin irritation
- Dizziness and nausea





# Health Consequences of Poor Indoor Air Quality

❖ Long-term health effects of pollutants:

- Respiratory diseases
- Heart disease
- Kidney disease
- Lung cancer



# Asthma Triggers

## Mold is an Asthma Trigger!

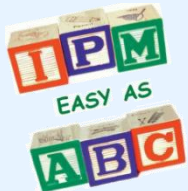
- ❖ Other common allergens and irritants include:
  - Dust and Dust Mites
  - Pet Dander, Saliva
  - Cockroaches, Mice, and Rats
  - Pollen
  - Chemicals and Volatile Organic Compounds (VOCs)
  - Secondhand Smoke and Combustion Products

For more information on these triggers, please see the learning module: *Asthma Triggers in Sensitive Environments*



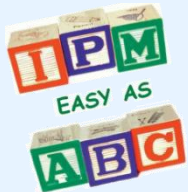
# Managing Air Quality

- ❖ Reduce pollutants at the source!
- ❖ Exhaust pollutants and increase ventilation and air circulation
- ❖ Additional air filtration may be needed after source reduction and ventilation have been addressed



# Managing Air Quality

- ❖ Increasing ventilation after source control can help reduce some pollutants
- ❖ Add mechanical ventilation such as:
  - Air to Air Heat Recovery Ventilation (HRV) Units
  - Energy Recovery Ventilation (ERV) Units
  - Bathroom vent



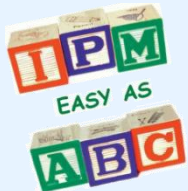
# Managing Air Quality



Photo: University of Nebraska–Lincoln

**Air to Air Heat Exchanger**

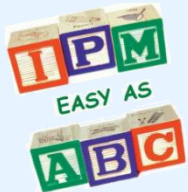
- ❖ Air to Air Heat Exchangers provide fresh intake air to buildings while pre-cooling or heating the intake air with transfer from the exhaust air. Some also pre-filter and control humidity levels as well.



# Mold and Moisture



Photo: University of Nebraska–Lincoln



# Mold Basics



Mold is a fungi that lives on plant and animal matter. To survive, it requires:

- ❖ Moisture source
- ❖ Food (organic materials)
- ❖ Oxygen

**Mold is a pest!**



# Mold as a Pest

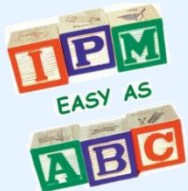
- ❖ Prefers warm, humid, dark places
- ❖ Feeds on damp organic materials
  - Wood, paper, carpet, soil, and other materials
- ❖ Studies link indoor mold and dampness to respiratory problems





# Molds can produce substances with negative effects on health...

- ❖ VOCs—odors
- ❖ Micotoxins—200+ from common molds at certain times in their life cycle
- ❖ Glucans (pieces of mold cell walls)
- ❖ Spore allergens—remain allergenic even when dead or dormant



# Sources of Moisture

- ❖ Inadequate ventilation
- ❖ Changes in building construction
  - Use of materials like drywall, which does not allow easy escape for moisture
- ❖ Roof leaks, non vented combustion appliances, gutters that direct water toward or under building



# Preventing Mold

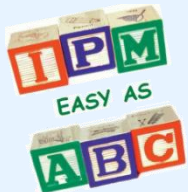
- ❖ Keep humidity between **30-50%** as much as possible
  - Use dehumidifiers in humid areas
- ❖ Early discovery and moisture control
  - Check susceptible areas regularly
  - Can you smell it? See it?
- ❖ Increase mechanical ventilation
  - Air to air heat recovery units or heat exchangers
- ❖ Keep areas clean, remove trash



# Preventing Mold

## Moisture Control

- ❖ Fix water and moisture problems, such as leaks and flooding
- ❖ Maintain HVAC system
- ❖ Reduce condensation
  - Clean up wet spots within **24-48 hours**
  - Increase air circulation
  - Reduce humidity
  - Warm up surfaces



# Preventing Mold

## Moisture Control

- ❖ Vent moisture-generating appliances (dryers, bathroom vents, etc.)
- ❖ Perform regular building maintenance inspections, including HVAC
- ❖ Keep HVAC drip pans clean, flowing properly, and unobstructed



# Preventing Mold

## Moisture Control

- ❖ Install and use exhaust fans in kitchen and bathrooms, shower rooms
  - Vent to the outside
- ❖ Clean out gutters and downspouts regularly
- ❖ Don't let foundations stay wet and seal foundation cracks
- ❖ Avoid putting carpet on basement or slab materials that may absorb moisture



# Preventing Mold

- ❖ Maintain and clean appliances where molds can grow
  - Heating and cooling systems
  - Humidifiers
  - Dehumidifiers
  - Refrigerator drip pans



# Preventing Mold

## Plants

- ❖ Use good quality, pasteurized soil mixes for indoor plants
- ❖ Avoid overwatering as mold may grow in and on the soil. Constantly wet soil will attract Fungus Gnats and Phorid Flies



Photo: University of  
Nebraska–Lincoln



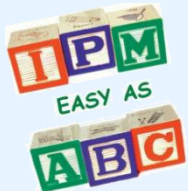


# Preventing Mold

- ❖ Keep surfaces clean and dry
  - Locker rooms, showers, bathrooms
  - Kitchen cupboards and under sinks
  - Places where condensation occurs



Photo: University of Nebraska–Lincoln



# Investigating and Mitigating Molds

- ❖ Assess the extent of damage; determine if remediation should be done in-house or out.
- ❖ If hiring a contractor, make sure the person has experience cleaning up mold. Check references and ask the contractor to follow the recommendations of EPA guide: *Mold Remediation in Schools and Commercial Buildings* and/or NY City Health Dept.



# Investigating and Mitigating Molds

## ❖ Avoid

- Touching moldy items with bare hands
- Getting mold or spores in eyes
- Inhaling mold or mold spores

## ❖ Use personal protective equipment (PPE)



Photo: University of Nebraska–Lincoln



# Mold Hiding Places

- ❖ Under carpets and wallpaper
- ❖ Pipe chases
- ❖ Utility tunnels
- ❖ Condensate drain pans inside air handling units
- ❖ Walls behind furniture

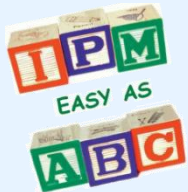


Photo: University of Nebraska–Lincoln



# Mold Hiding Places

- ❖ Top of ceiling tiles
- ❖ Back side of drywall or paneling
- ❖ Porous liners inside ductwork
- ❖ Roof materials above ceiling tiles  
(due to roof leaks or insufficient insulation)



# Tools for the Search...



Photo: University of Nebraska—Lincoln

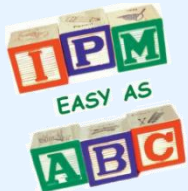
**Moisture meter**

- ❖ Moisture meter
- ❖ Hygrometer—humidity gauge
- ❖ Boroscope—to see in hard to reach places
- ❖ Goggles, gloves
- ❖ N-95 mask minimum



# Before Remediation Begins, Consider:

- ❖ Are there existing moisture problems in the building?
- ❖ Have materials been wet more than 48 hours?
- ❖ Are there hidden sources of water or is humidity too high?
- ❖ Are there reports of musty or moldy odors?



# Before Remediation Begins, Consider:

- ❖ Are building materials visibly damaged?
- ❖ Has maintenance been delayed or maintenance plan been changed?
- ❖ Has the building use changed or has there been recent remodeling?
- ❖ Is consultation with medical professionals indicated?

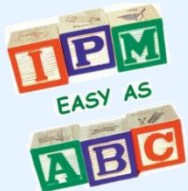






# Basic Remediation Steps

- ❖ Fix water and humidity problems; revise maintenance plans
- ❖ Communicate with building occupants, address all concerns
- ❖ Wear appropriate PPE and completely clean up mold; dry all water damaged areas.
- ❖ Contain and remove all moldy materials properly



# Mold Clean-Up Tips

If you experience water damage, you can prevent, minimize, or remove mold growth by following these steps for clean-up:

- ❖ Wet vacuum. Can be used on most surfaces where water has accumulated.
- ❖ Damp wipe. Mold can be cleaned from nonporous surfaces with water and detergent. Be sure to dry surfaces quickly to discourage further growth.



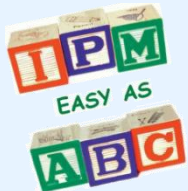
# Mold Clean-Up Tips

- ❖ HEPA (High-Efficiency Particulate Air) Vacuum. This is good for final clean-up of remediation areas after thorough drying has been completed. It can pick up dust and other particles left behind in the area.
- ❖ Discard/Remove contaminated/damaged materials and seal in plastic bags. Double bag and discard in ordinary construction waste.



# Mold Clean-Up Tips

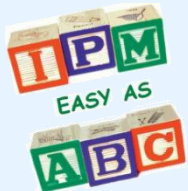
- ❖ Gently spray area to wet and keep spores from spewing
- ❖ Capture and contain spores
- ❖ Wrap or cover porous materials and wrap in plastic before removal



# Removing Mold



- ❖ Avoid direct contact and inhalation of molds and mold spores
  - Wear personal protective equipment—minimum N 95 HEPA mask, gloves, goggles, protective clothing
  - Adequate clean air supply
  - Follow label directions on cleaning products



# Removing Mold

- ❖ Wash mold off hard surfaces with detergent and water, and dry completely. Use HEPA vacuum
  - Moldy absorbent materials should be replaced
  - Detergent and water help to remove the organic matter that fungi feed on.
  - "Capture" spores to prevent them from dispersing
- ❖ Clean and remove mold when building is not occupied



# Removing Mold

- ❖ Biocides and fungicides are products that kill or inhibit living organisms and fungi but are generally not recommended for normal routine clean-up of mold and mildew
  - Don't always kill all the spores
  - Some disinfectants are not as effective with organic matter (wood, paper, soil)
  - Be sure to use detergent or all purpose cleaner and water if a disinfectant is used on surfaces
- ❖ To clean mold in areas of dirty water (sewage, floods, etc.), use disinfectants

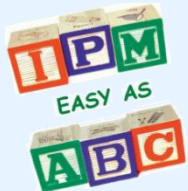


# Removing Mold

- ❖ Use detergent and water for clean-up as first line of attack
- ❖ Aerosols can cause spores to spread
- ❖ Dead and dormant spores can still be allergenic



Photo: University of Nebraska–Lincoln





# Removing Mold

- ❖ Remaining mold spores can grow and create new colonies if moisture levels have not been corrected. Some spores will probably remain in the area even with disinfectant use
- ❖ Follow facility policies for use of disinfectants and other cleaning products; read the label and the Safety Data Sheets (SDS)



# Use of Biocides

- ❖ Some biocides are considered pesticides
  - Follow label directions
  - Use non spray or non aerosolized biocides
- ❖ Very few pesticides (biocides) have been approved by EPA for use in duct systems and only in unlined metal systems. (See EPA's publication: *Should You Have the Air Ducts in Your Home Cleaned?*)
- ❖ Fungicides developed for outdoor use should **not** be used in any indoor application unless that indoor location is also listed on the label.



# Biocide Examples



- ❖ Sodium hypochlorite (chlorine bleach)
- ❖ Quaternary ammonium compounds
  - Possible asthma trigger
- ❖ Phenolics—phenol is listed in the ingredients
- ❖ Pine oil
- ❖ Hydrogen peroxide—may be more tolerable for sensitive persons



# Mold Containment

- ❖ Limits release of mold during remediation
- ❖ Two kinds:
  - Limited
    - ✓ For areas involving between 10-100 sq. ft. of mold contamination
  - Full
    - ✓ For areas involving over 100 sq. ft. of mold contamination



Photo: Hometest, METS Labs



# Mold Containment

- ❖ Use double layers of polyethylene to create barrier between moldy area and other parts of the building
- ❖ Maintain containment area under negative pressure relative to surrounding areas. Can be accomplished by using HEPA filtered fan unit exhausted to outside of the building



# Determining when Remediation is Complete



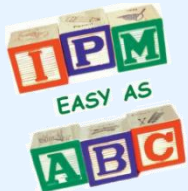
- ❖ Water problem fixed
- ❖ Mold removal completed
- ❖ Sampling done for mold spores in the building once clean-up has been completed
- ❖ Site revisited soon after remediation to check for signs of mold growth or water damage
- ❖ Occupants do not have health complaints or physical symptoms pertaining to mold



# Other Mold "Remedies"

## Ozone Air Cleaners

- ❖ At concentrations that do not exceed public health standards, ozone is not effective at removing many odor-causing chemicals or viruses, bacteria, mold, or other biological pollutants
- ❖ Ozone is a lung irritant and may trigger asthma



# Other Mold "Remedies"

## Use of Ultraviolet Light

- ❖ UV light shows some promise in mold spore control, however, the light must penetrate through the mold to reach spores underneath
- ❖ Mold species respond differently to the amount of UV light effective in killing the spores



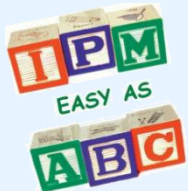


# IAQ Management Summary

- ❖ Good housekeeping and maintenance practices
- ❖ Good ventilation essential!
- ❖ Eliminate sources of contamination



Photo: University of Nebraska–Lincoln



# IAQ Management Summary

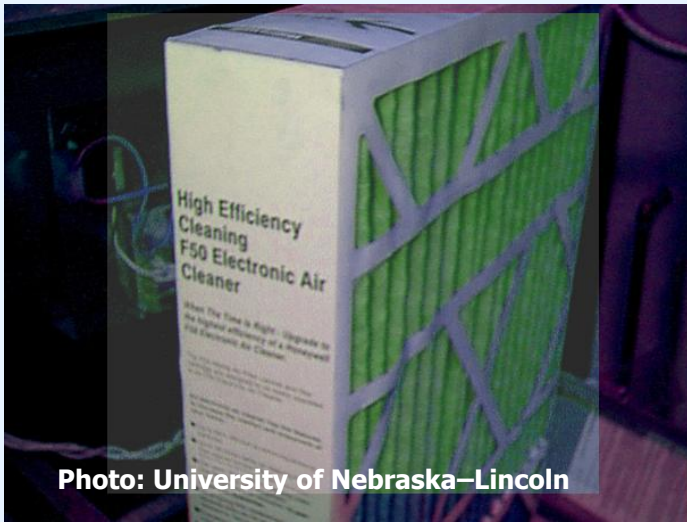
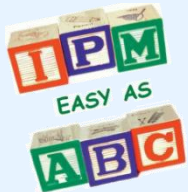


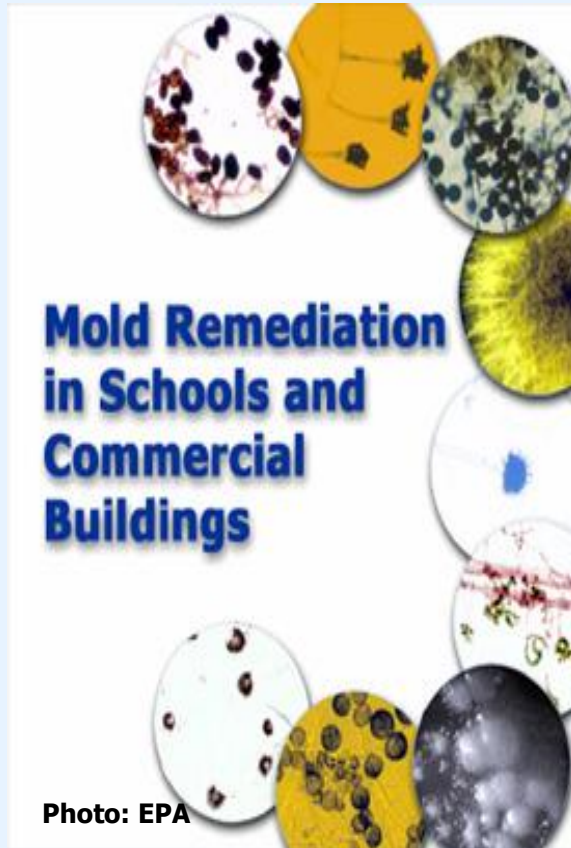
Photo: University of Nebraska–Lincoln

**HEPA filter**

- ❖ Remediate moisture problems as quickly as possible to prevent mold
- ❖ Maintain HVAC equipment and high efficiency filters
- ❖ Use vacuums with high efficiency filters (HEPA)



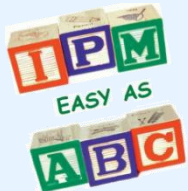
# Additional Resources



❖ EPA  
Guidelines/Publications:

[http://www.epa.gov/mold/  
mold\\_remediation.html](http://www.epa.gov/mold/mold_remediation.html)

800-438-4318



# Additional Resources

- ❖ New York City Health Department Guidelines:

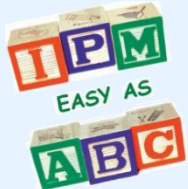
<http://www.nyc.gov/html/doh/html/environmental/moldrpt1.shtml>

212-788-4290

- ❖ American Conference of Government Industrial Hygienists: Bioaerosols: Assessment and Control

<http://www.acgih.org> (search for Bioaerosols)

513-742-2020



# Credits

## ❖ Content Specialist

- Shirley Niemeyer, Nebraska Extension Professor Emeritus

## ❖ Content Editor

- Erin Bauer, Nebraska Extension

## ❖ Photos

- Shirley Niemeyer, Nebraska Extension Professor Emeritus
- USDA



# Credits

## ❖ Photos cont.

- EPA
- Hometest, METS Labs
- UNL Extension

**Note: Photos and artwork not credited are public domain/clipart**

