

Environmental Management of Asthma: Home Ventilation and Filtration



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More details here: <https://www.cdc.gov/asthma/>

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 - a. Windows computers - Ctrl-Z
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This will restore any items accidentally deleted.

I may ask you do this several times.



Who Am I?



Kevin Kennedy, MPH, CIEC

- 30 years' experience as an environmental health scientist
- 21 years' working at Children's Mercy Kansas City (CMKC)
- Our program has assessed thousands of homes and schools, providing patient families, childcares, and schools
- Our program received over \$7million in program and research grants
- I've been part of 9 HUD(4 Healthy Home Program Grants, 5 HUD research grants) and many more pubic and private.
- I am a co-author on more than 50 academic research publications
- I am the primary author of the BPI Healthy Housing Principles Reference Guide (used for this class)
- I teach professional courses in environmental health assessment and investigations, environmental measurement and sampling, building science, and general healthy homes science and research.
- I am a Certified Indoor Environmental Consultant
- I have previously worked as an environmental analytical chemist, research scientist in extractive metallurgy, historic home restoration carpenter and woodworker.

More information on my website [here](#):



Many kinds of shelter serve as homes

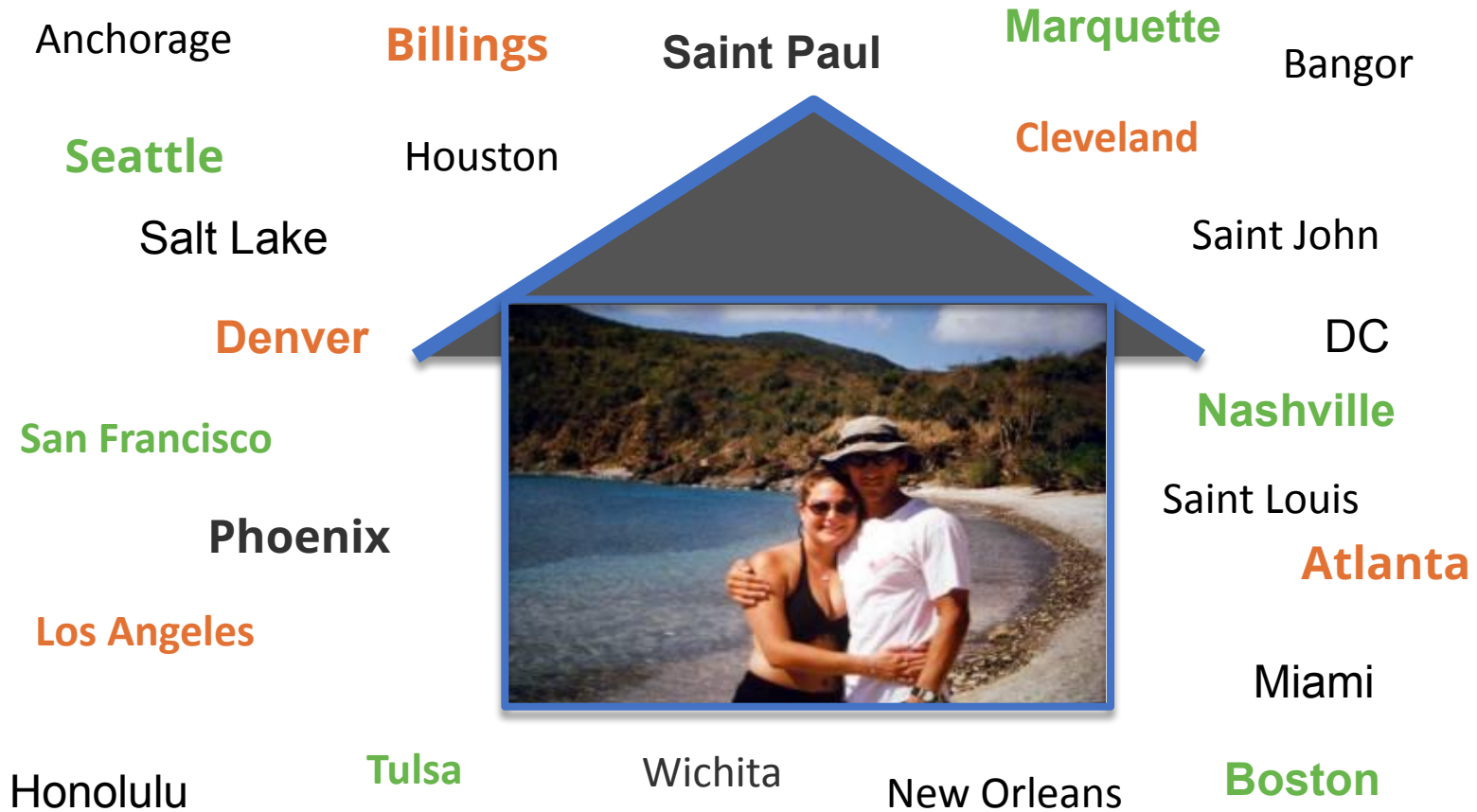


But they all have
the same goal



Indoor comfort

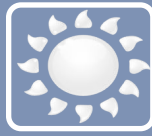




Homes everywhere are designed to provide the same indoor environmental conditions no matter where they are



Homes shelter us from:



Sun



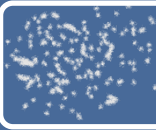
Wind



Rain (sleet, snow)



Cold or hot air



Dust



Animals and insects

Most of us are comfortable in these ranges:

Air temperature: 65° F(active) –
80° F (bathing)

Air relative humidity: 30% – 60%

Air motion: 20 – 40 feet per minute

Surrounding surface temperatures:
within 10 – 15°F of room air



Kevin believes all home visitors should promote:

Healthy Home “Keep it” Principles



Clean



Dry



Pest-Free



Contaminant-Free



Safe



Ventilated



Comfortable



Maintained



Homes are Systems

- “Fire” - heat transfers drive air flow
- “Air” - air movement creates pressure differences
- “Water” - moves from wet to dry
- “Earth” - dust infiltrates and circulates with air movement

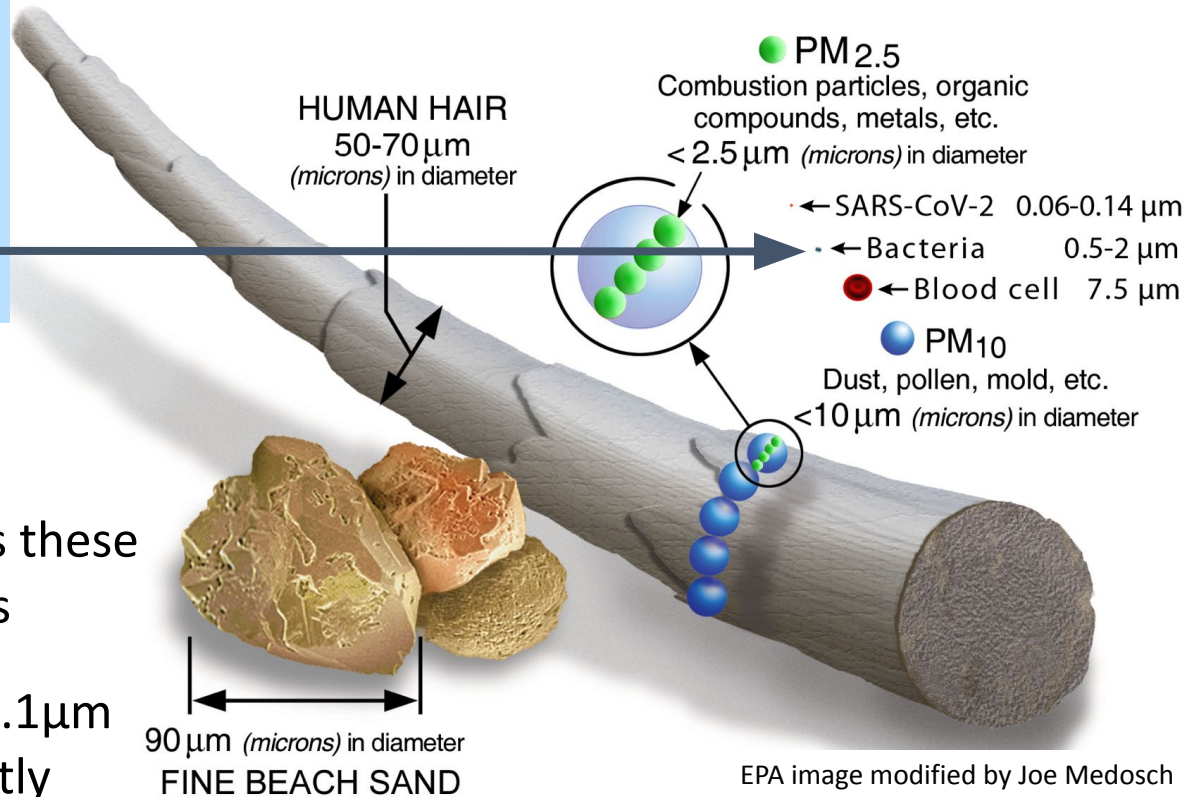


Particulate Matter, or breathable dust, can bypass natural defenses in our airways

Fine particulate are from 0.1 μm to 10 μm in size

PM_{2.5} means 2.5 μm particles these are inhaled deep into our lungs

Ultrafine particulate are < 0.1 μm in size. This size can pass directly into the bloodstream



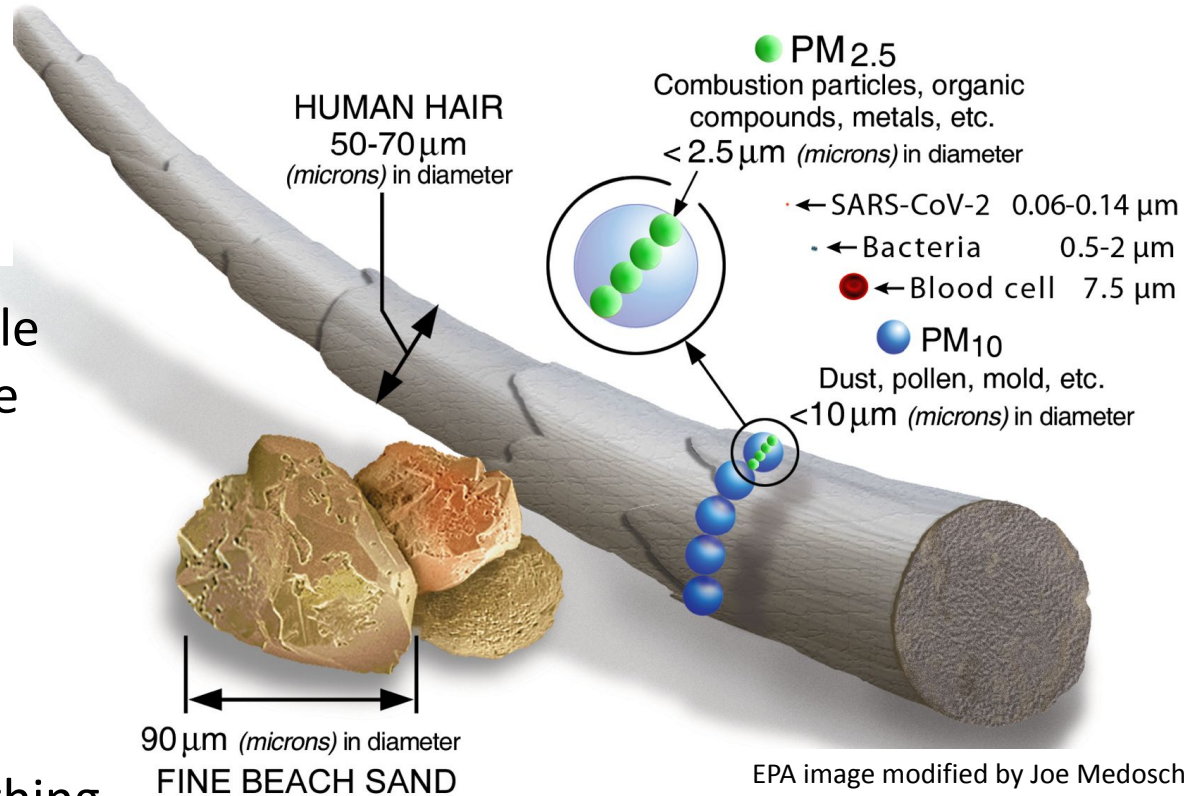
EPA image modified by Joe Medosch

Image ©2020 Building Performance Institute



There are major health effects known to be associated with fine particulate exposure

- Premature death in people with heart or lung disease
- Nonfatal heart attacks
- Irregular heartbeat
- Aggravated asthma
- Decreased lung function
- Irritation of the airways
- Coughing, difficulty breathing

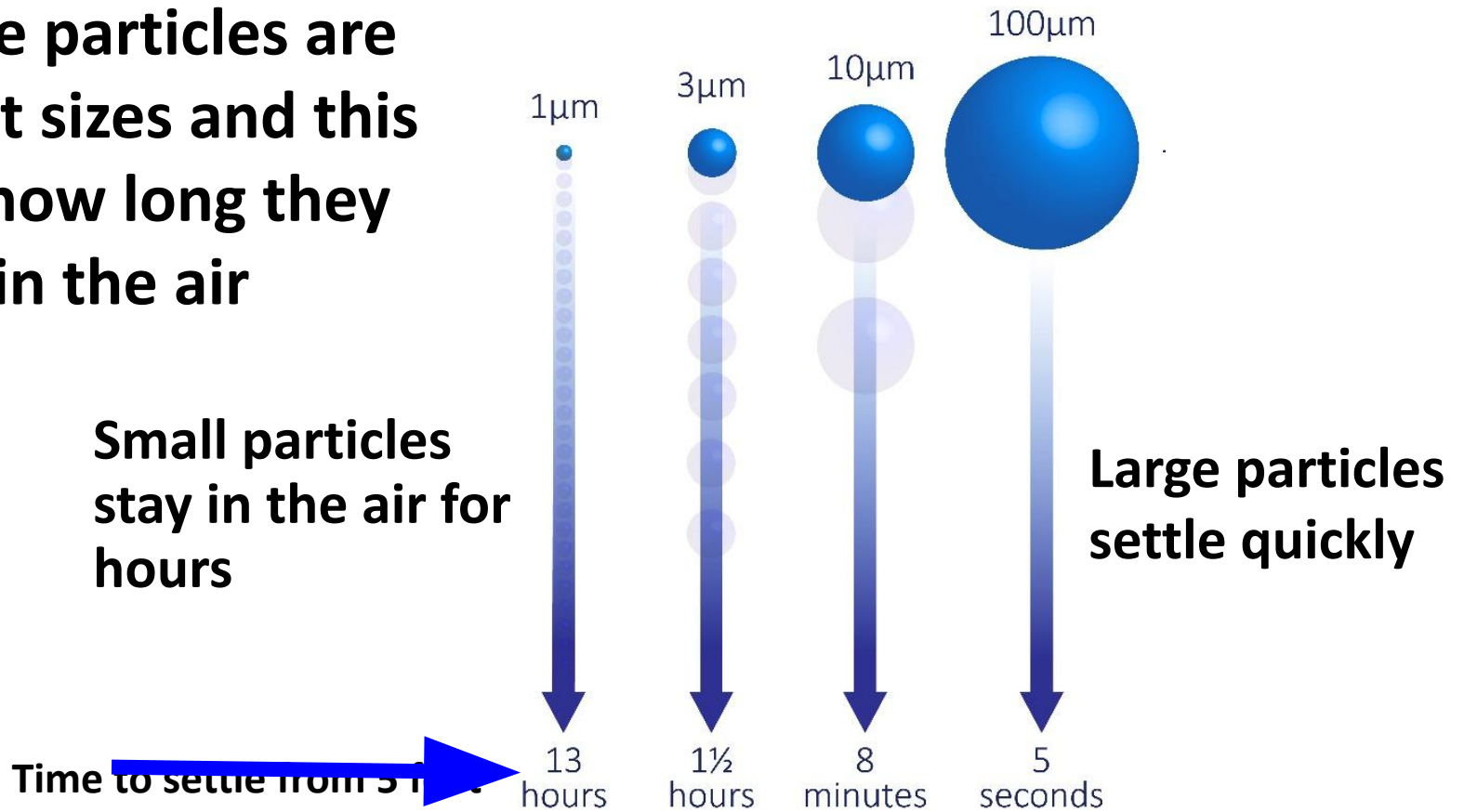


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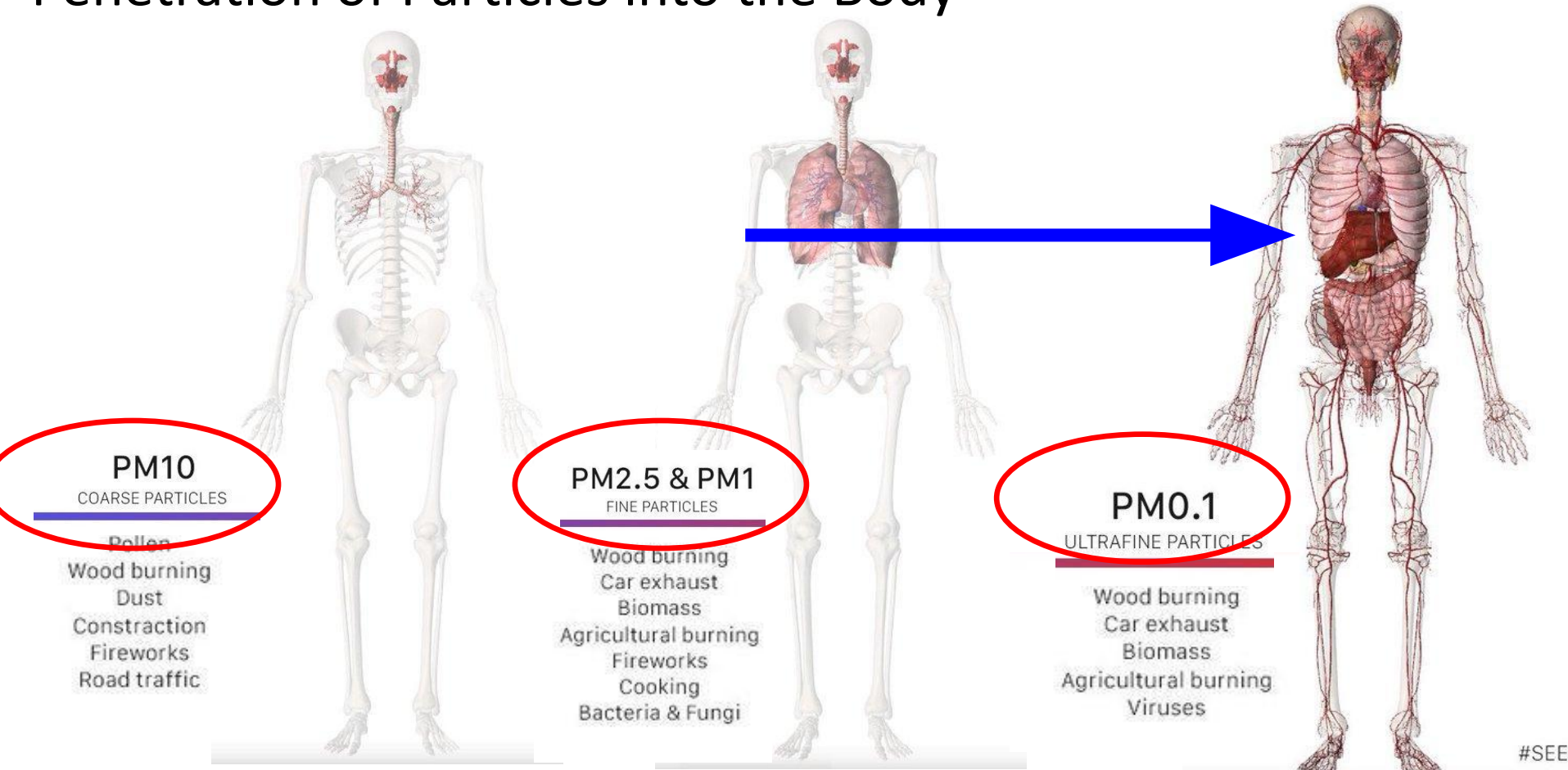
Airborne particles are different sizes and this affects how long they remain in the air



This slide is part of the Co-agency Asthma Education slide deck developed for Asthma Management Training. More details here: <https://www.cdc.gov/asthma/>



Penetration of Particles into the Body

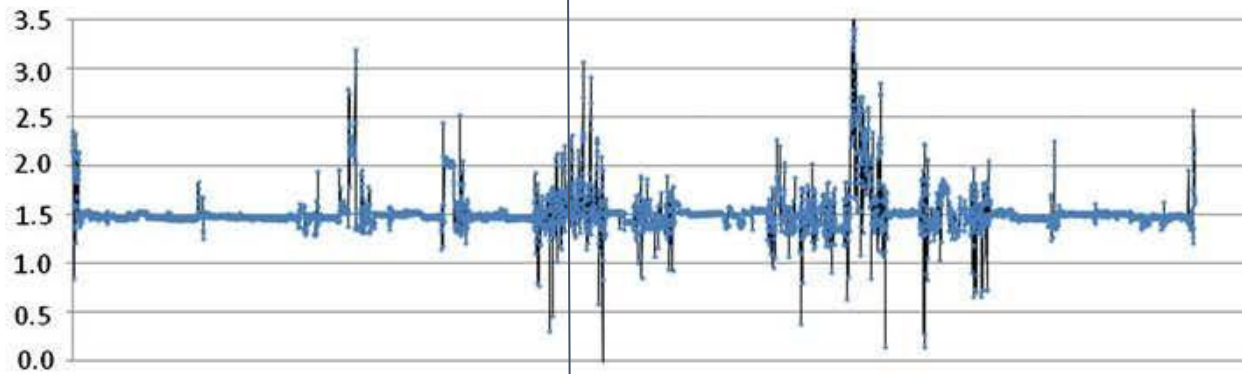


We all have a personal pollution “cloud”

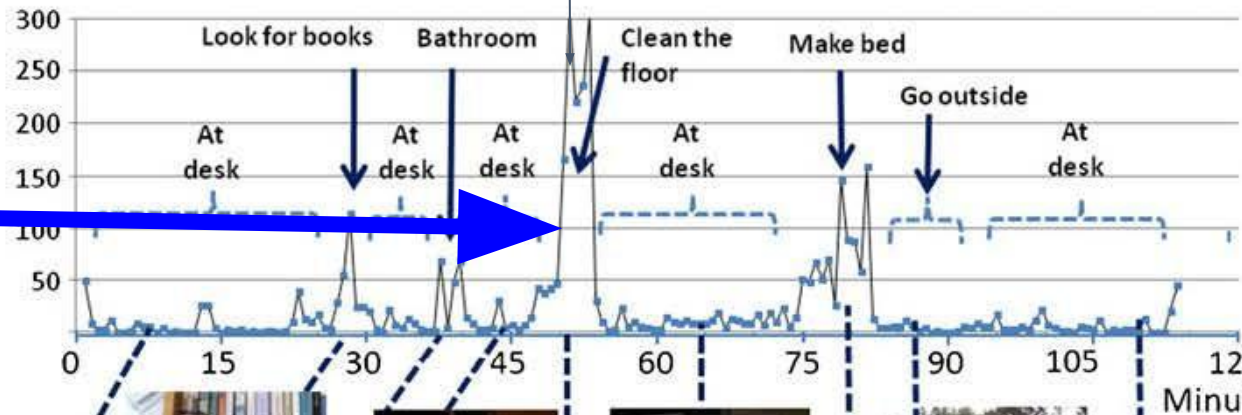


Tovey & Ferro, Time for New Methods for Avoidance of House Dust Mite and Other Allergens, Curr Allergy Asthma Rep, 2012

Movement (Σ 3D G)



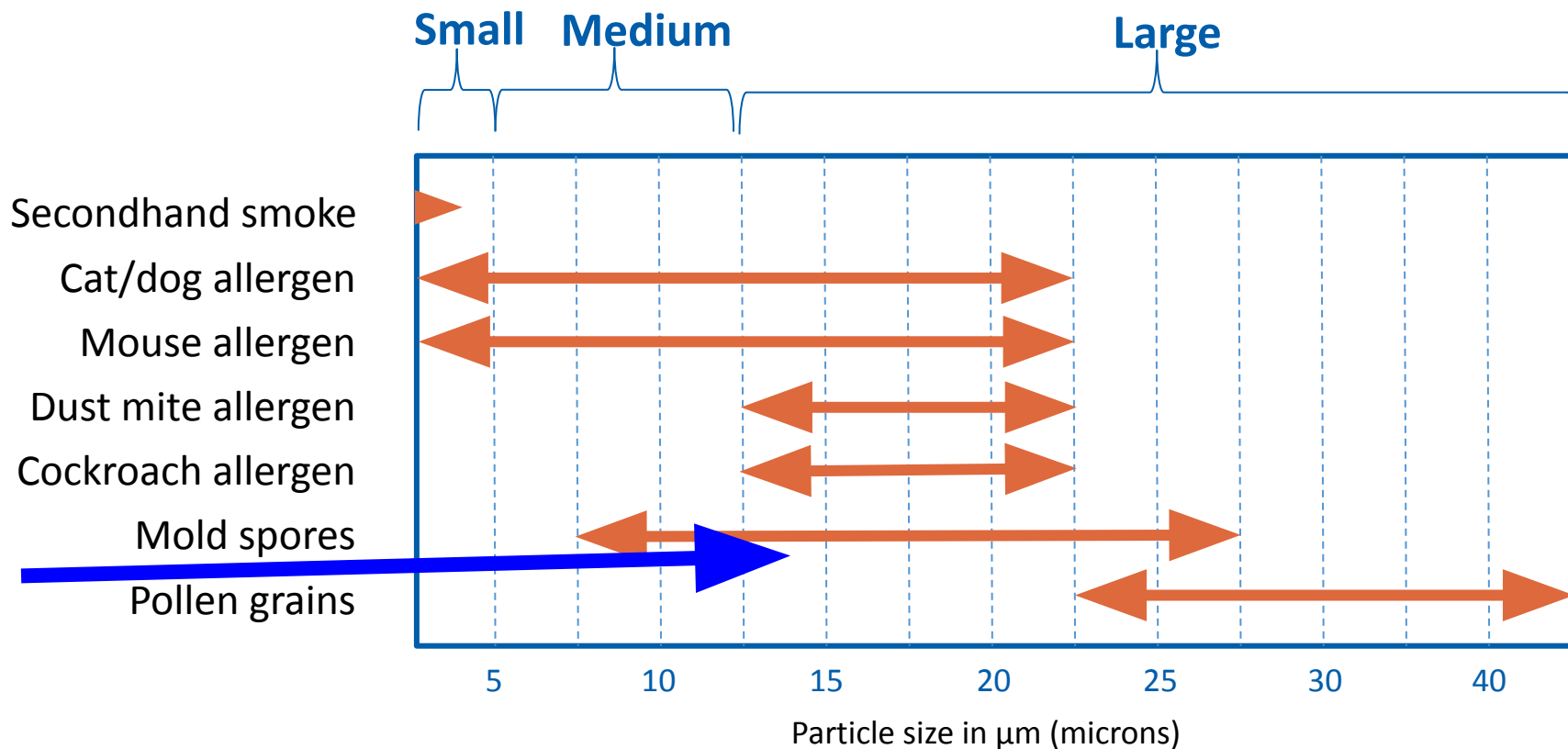
$10\mu\text{m} \times 10^3 / \text{M}^3$



Selected Images



Size range of asthma trigger particles in air



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Pests: Allergen characteristics

Mouse and rat allergens

- Mainly urine (but also in dander)
- Airborne allergens on a range of microscopic particles (<10 and $\geq$ 10 microns).
- Can remain airborne for hours.

Cockroach allergens

- Mainly fecal pellets (but also in dried body parts).
- Airborne allergens on larger, but still microscopic particles (mainly >10 microns).
- Settle out of air quickly.



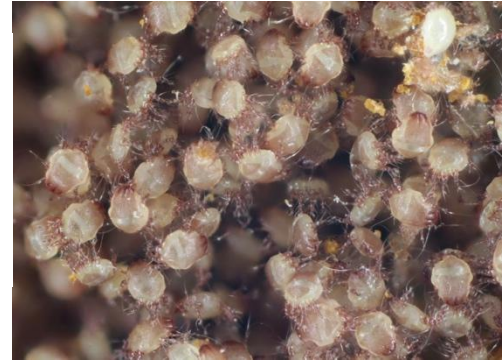
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Dust mites are tiny (microscopic) organisms that live in the dust of both humid and dry buildings.

- Eat mostly skin flakes or dander from humans and animals
- Need higher amounts of moisture and humidity to survive and thrive
- Inhabit woven fabrics, carpeting, upholstered furniture and stuffed animals
- ~80% of US homes have dust mite allergen in bedrooms**

Yucky video of dust mites -
Are you ready?
<https://www.youtube.com/watch?v=vlsxTB9dHg>



(Dust mites magnified 5000 times.)



Images ©2020 Building Performance Institute

**American Healthy Home Survey II, 2019
https://www.hud.gov/program_offices/healthy_homes/ahhs_ii



Dust mite allergen characteristics



Dust mite allergen

- Mainly droppings (fecal pellets)
- Airborne particles > 10 microns
- Settle out of air quickly
- Mainly exposed by breathing near surfaces with dust mites
- Not easily transferred passively (e.g. from clothes to sofa)
- Mainly found in soft fabric furnishings

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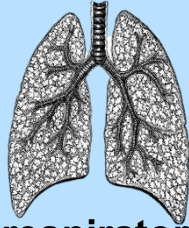


Second-hand smoke, or Environmental Tobacco Smoke is a significant hazard:

- Adult health effects
 - Well known to cause cancer and major respiratory diseases
- Children's health effects
 - Associated with asthma development and exacerbation of symptoms
- “Third hand smoke” is the chemical residues that absorb into home contents and off-gas into the air for years unless deep cleaning



Additional health effects of environmental tobacco smoke include:



- **Acute respiratory infections**
- **More severe asthma**
- **Lung cancer**
- **Chronic Obstructive Pulmonary Disease**
- **Pneumonia**
- **Emphyzema**
- **Bronchitis**



Coronary heart disease



Ear problems



Sudden Infant Death Syndrome (SIDS)



No matter the source, smoke is a health hazard

- **Electronic Cigarettes**
 - Diacetyl
- **Wild Fires**
- **Wood smoke**
- **Marijuana**



Exercise! Apply what we learned

You are visiting the Miller's home. Their daughter, Jessica, has asthma and is allergic to allergens from dust mites, grass pollen, and cats.

- Work in small groups.
- Review the the photo of Jessica's bedroom
- Discuss possible sources of particles you observe in the room

Your breakout room number should match the group number on the exercise slide



Group Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles you observe

Sources of particles
you observe



Group #1 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles you observe

Possible pet @ top left corner

Linens on bed mostly likely have dust mites

Scattered clothing piles collecting particles

Dust in books

Dust under shoe



Group #2 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles you observe

Lack of ventilation

Inability to dust/ vacuum

Accumulation of items that aren't
being thoroughly cleaned

Dust/ particles from the window

Dust/ particles from the vents or
blockage of

Hamster



Group #3 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles you observe
dust mites
window shades
clothes
bedding
book shelves
items in the corner room (clutter)
papers



Group #4 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles
you observe

Dust mites

Pests- ants, cockroaches

Pollution outside

Poor ventilation



Group #6 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles
you observe



Group #7 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles
you observe

dust mites

Lack of Ventilation

clutter

linens / bedding/ pillows



Group #8 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles you observe

woven articles

outdoor clothes on bed

clutter, hard to clean

closed window

shoes on top of furniture

animal cage?



Group #9 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles
you observe

clutter

Dark, lack of ventilation

Moisture source - curtains pulled
down



Group #10 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles you observe

Sources of particles you observe
clutter
open windows, ventilation
vacuum
pet cage



Group #11 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles
you observe



Group #5 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles you observe
Clutter
Dust Mites
shoes, clothes
Trash
Books
lack of air flow
No clear path
Dirt



H

Group #12 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles you observe

Because of all the stuff it will be very hard to vacuum or wash the bedding.

There are a lot of surfaces that will collect dust the papers should be in cabinets or boxes. The clothes should be in drawers.

Lack of air flow (



Group #13 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles
you observe



Group #14 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles
you observe

Clothes on bed and floor

Shoe on top of cubby

Toys near the corner of the window (if
it has been left there for awhile)

Clutter of books on shelves

Clutter on the floor (carpet flooring?)



Group #15 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles
you observe



Group #16 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles
you observe



Group #17 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles you observe
Clutter
Book pages and stacks
Curtains
Clothing
Sheets and pillows
Carpet
Ventilation (closed windows)



Group #18 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles
you observe



Group #19 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles
you observe

airborne

safety hazard

dust

pest

ventilation issues



Group #20 Exercise: You're visiting the Miller's home. This is their daughter Jessica's bedroom. What are some likely sources of particles and allergens in this room?

Sources of particles
you observe

dust/dust mites - hard to clean,
cluttered

window covers - dust build up and
prevents ventilation

hard to detect issues with mold or
moisture

shoe inside - might be tracking dirt
and pollen into bedroom

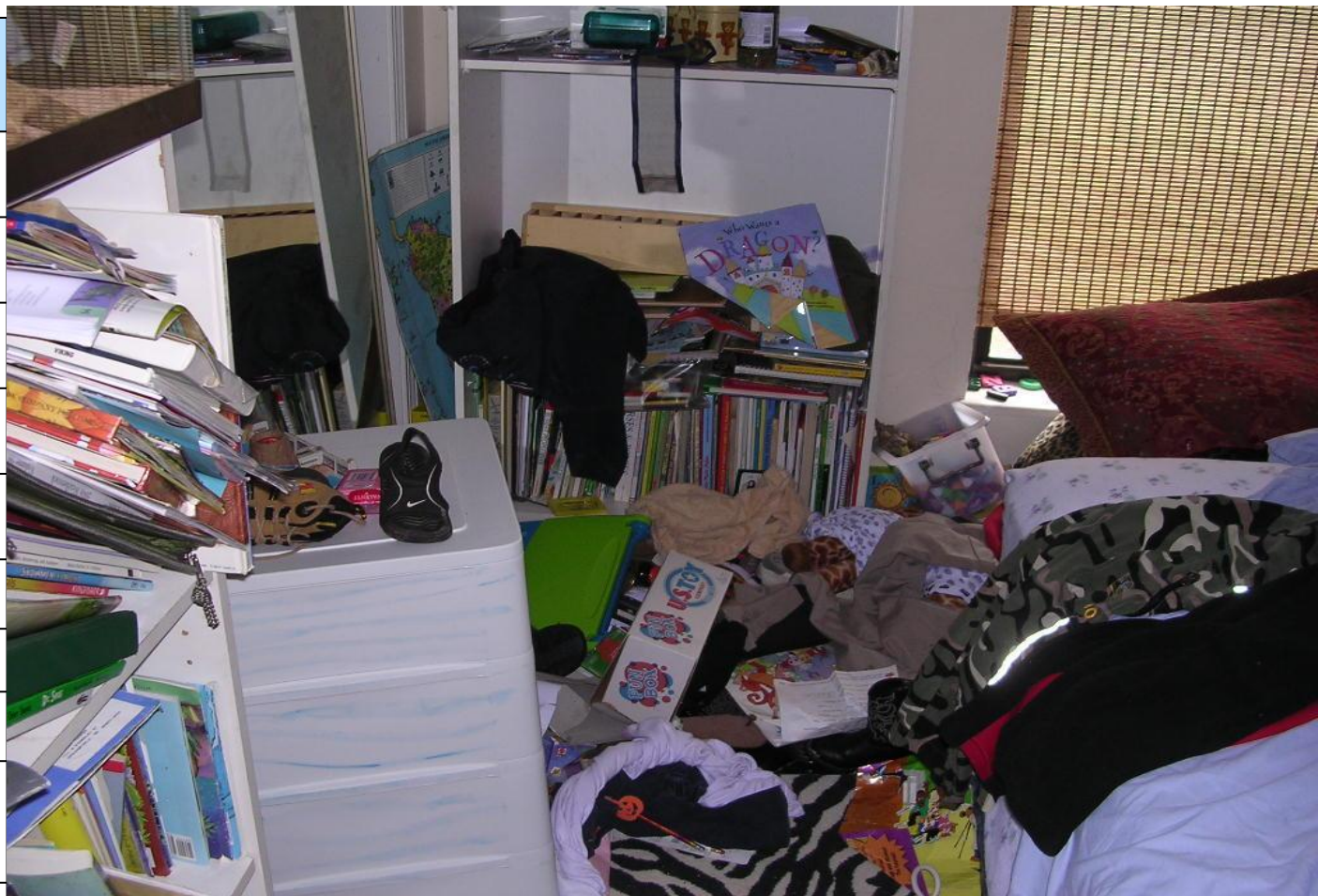
many many books/paper - fibers and
paper filaments airborne

pillow cover - might be harboring dust

pet cage - chemical offgassing?

depression/stress

bed and bookcase up against exterior
exposing wall without space
-ventilation issues.



Let's talk about a Healthy Home Principle that includes strategies for managing breathable particles and gases

Keep it Ventilated



KEEP IT
VENTILATED



Clean



Dry



Pest-Free



Contaminant-Free



Safe



Ventilated



Comfortable



Maintained



There are 3 primary mechanisms that drive airflow, ventilation, and circulation in homes

Stack Effect-

Air flow associated with heat and thermal transfer

Wind Effect-

Air flow associated with wind and air currents from outside the building

Passive
Ventilation

Mechanical and other forms of ventilation-

Air flow associated with mechanical systems and different fans that either move air out of a house, into a house, or around a house.

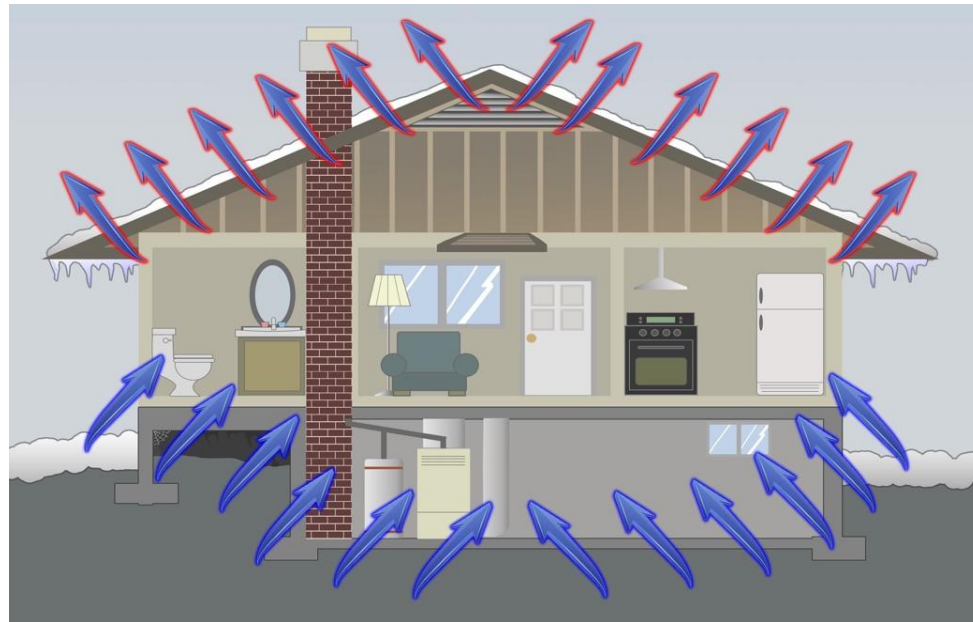
Active
Ventilation



Key concepts for understanding air movement and ventilation in homes

Stack Effect

Stack Effect - Warm air in homes rises up and out of the house through points of exfiltration. As this happens, it creates pressure that draws an equal amount of cooler air from outside in from areas around the bottom through any cracks, gaps, or openings.



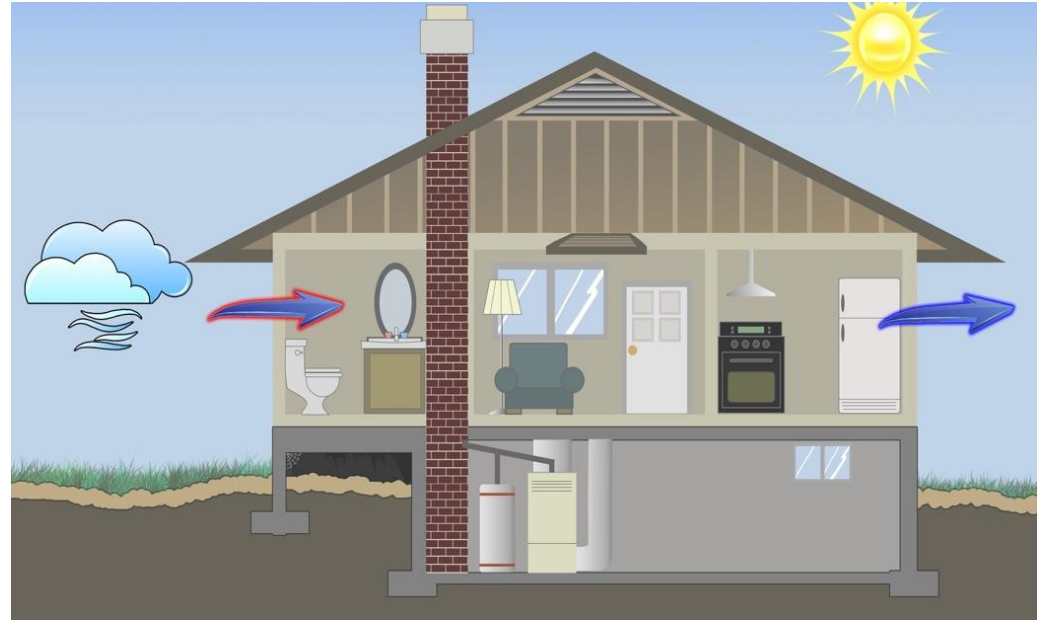
Images ©2020 Building Performance Institute



Another key concept that impacts air movement and ventilation in homes - the wind outside

Wind Effect - wind can enter through a drafty window on one side of a house. When this happens, an equal amount of air exits through an opening elsewhere.

Wind Effect



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Good ventilation is critical for maintaining good air quality in homes

Ventilation helps reduce the build-up of these contaminants in homes

- Airborne molds & pollens
- Breathable particles
- Allergens
- Carbon Monoxide (CO)
- Environmental Tobacco Smoke
- Moisture
- Nitrogen Dioxide (NO₂)
- Volatile Organic Compounds
- Carbon Dioxide (CO₂)



**Exhaust ventilation uses
designed holes to remove
contaminants**

**What is ventilation
vs. air circulation?**

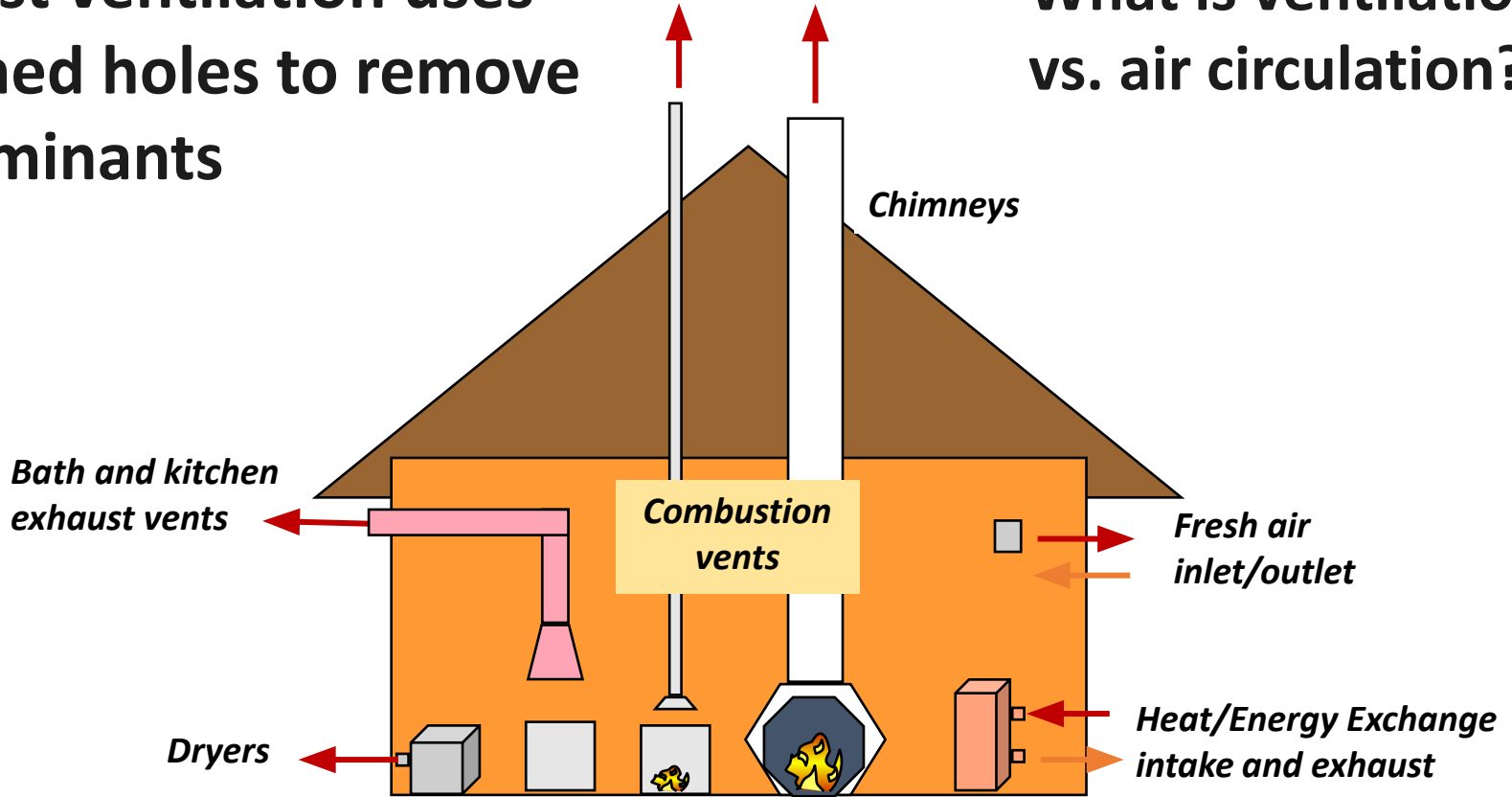


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There are areas in the home that need exhaust ventilation known as “spot ventilation”

Use a combustion fuel

- Gas furnaces & boilers
- Gas water heaters
- Fireplaces, wood burning stoves
- Gas clothes dryers
- Gas stoves and ranges

Use electricity as “fuel”

- Bathrooms
- Electric clothes dryers
- Electric stoves and ranges



These are common systems that create combustion byproducts from burning fuels

- Gas furnaces & boilers
- Gas water heaters
- Fireplaces, wood burning stoves
- Gas clothes dryers
- Gas stoves and ranges



All require exhaust ventilation



Poor ventilation is known to be associated with specific health impacts

- Respiratory irritation
- Common colds
- Influenza
- Pneumonia
- Bronchitis
- Increased allergy symptoms
- Increased asthma symptoms



Image ©2020 Building Performance Institute

...and increased rates of absence from school or work



When fuels are burned, **combustion by-products** are generated. Two of these have well-known health effects

Carbon Monoxide (CO)

- Fatigue, headaches, dizziness, confusion, unconsciousness, death
- The “Silent Killer”

Nitrogen Dioxide (NO₂)

- Eye, nose, and throat irritation
- Shortness of breath

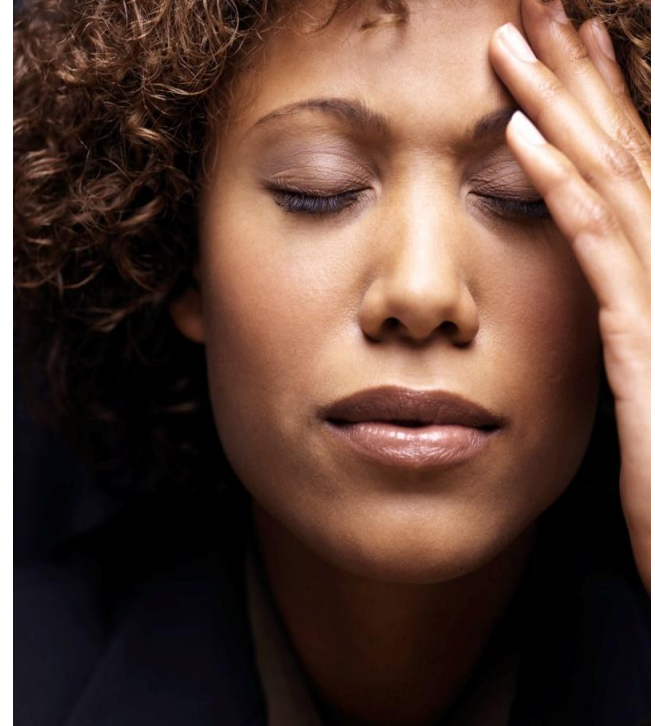


Image ©2020 Building Performance Institute



Here's a summary of the health effects from carbon monoxide poisoning

Symptoms of Carbon monoxide poisoning

- Dizziness
- Headache
- Disorientation
- Impairment of the cerebral function
- Coma

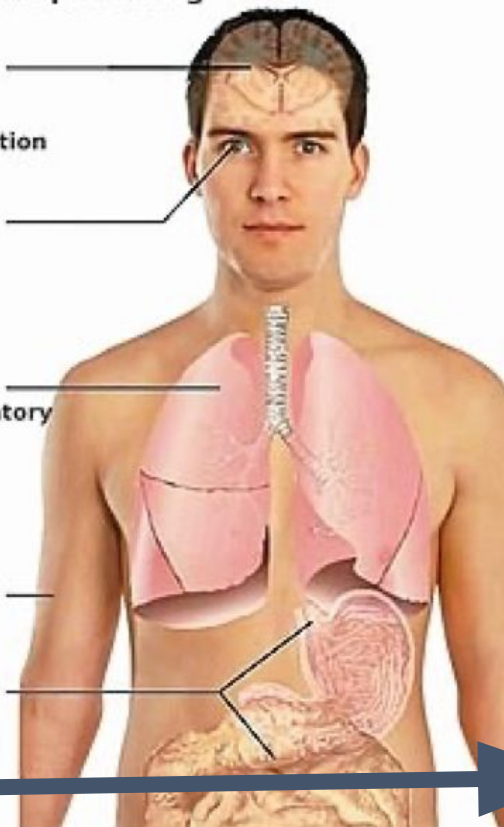
- Visual disturbances

- Disease of the heart and respiratory

- Muscle weakness
- Muscle cramps
- Seizures

- Nausea

- Aggravation of pre-existing diseases



PPM	% CO in air	Health Effects in Healthy Adults	Source/Comments
0	0%	no effects; this is the normal level in a properly operating heating appliance	
35	.0035%	maximum allowable workplace exposure limit for an eight-hour work shift	The National Institute for Occupational Safety and Health (NIOSH)
50	.005%	maximum allowable workplace exposure limit for an eight-hour work shift	OSHA
100	.01%	slight headache, fatigue, shortness of breath, errors in judgment	
125	.0125%		workplace alarm must sound (OSHA)
200	.02%	headache, fatigue, nausea, dizziness	
400	.04%	severe headache, fatigue, nausea, dizziness, confusion; can be life-threatening after three hours of exposure	evacuate area immediately
800	.08%	convulsions, loss of consciousness; death within three hours.	evacuate area immediately
2,000	1.2%	nearly instant death	

These are other common uncontrolled sources of combustion byproducts

- Car exhaust from attached garage
- **Spillage** from furnace, water heater, fireplace
- Oven as heater
- Ventless heaters & fireplaces

Draft hood

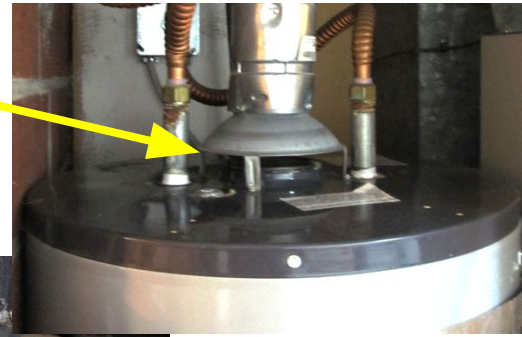


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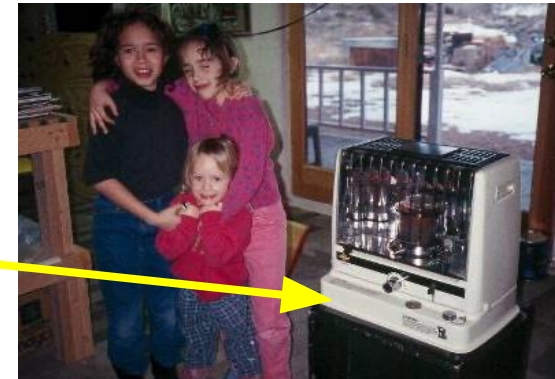


Image from the National Center for Healthy Homes



Sometimes when rooms are under too much negative air pressure, this can cause **backdrafting** of combustion appliances

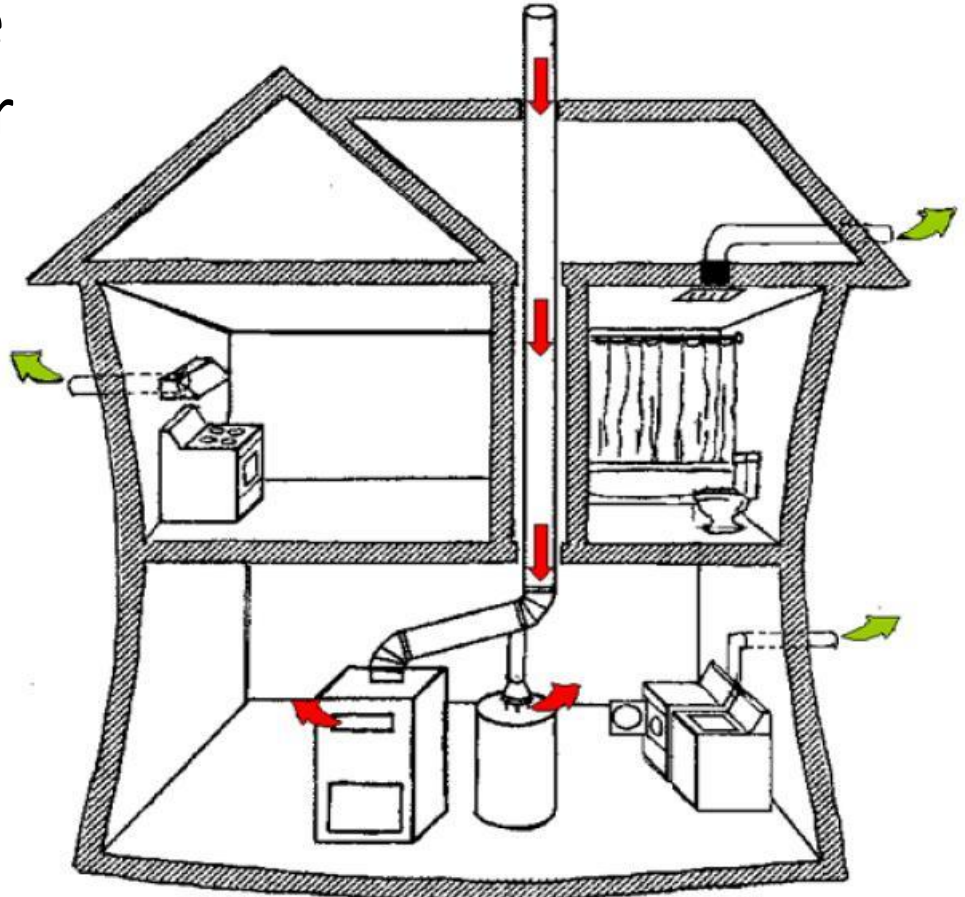
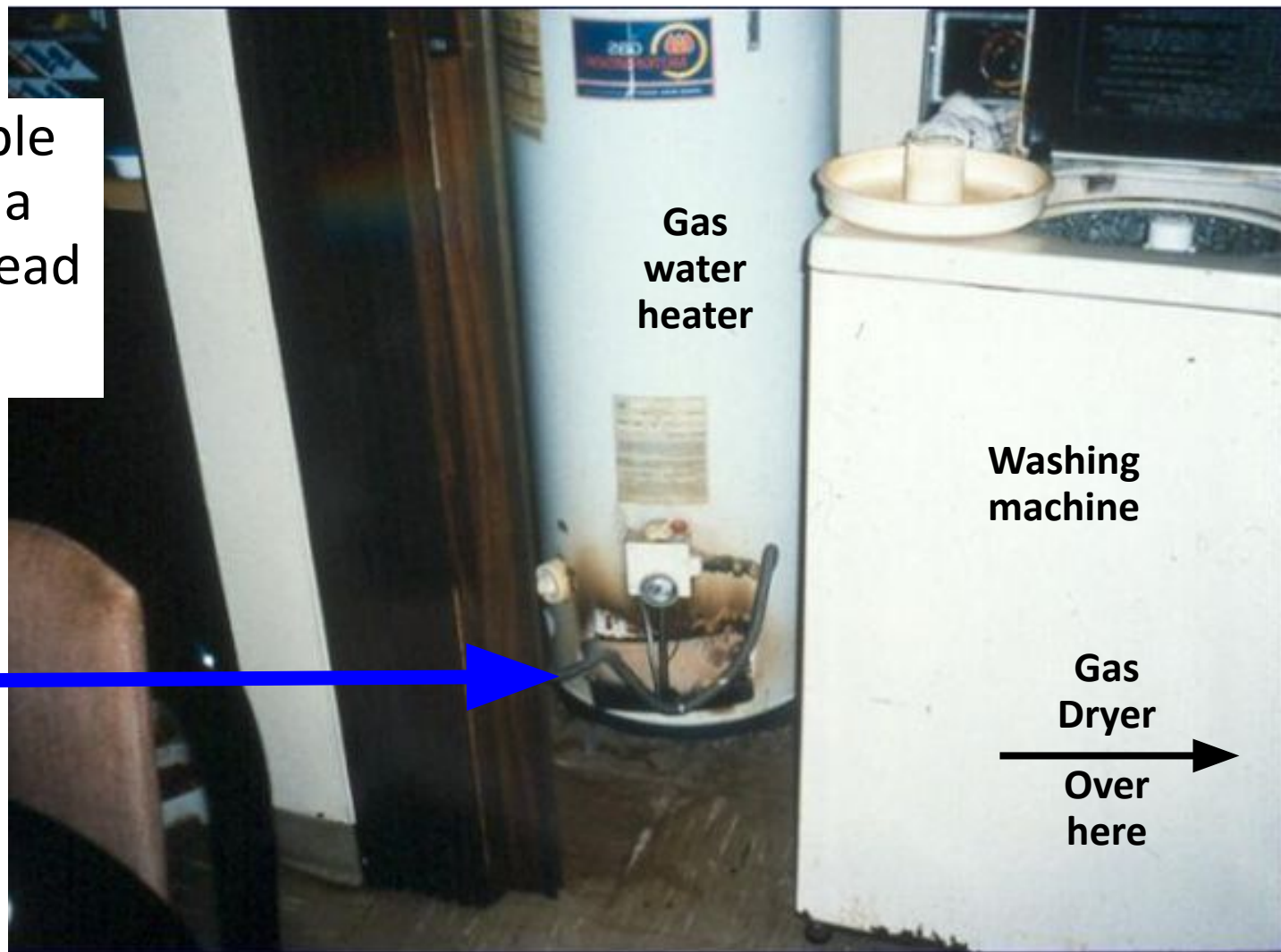


Image from natural-resources.canada.ca



Here's an example of a situation in a home that can lead to backdrafting.



Kitchens are one of the main locations in homes where chemicals and pollutants are created

Every time we cook food on a stove or in the oven we create:
Moisture, particles, smoke,
chemicals and odors

If we cook with a combustion
gas, we create:
Carbon monoxide (CO),
nitrogen dioxide (NO₂), and
other hazardous chemicals



**Kitchens need good exhaust fans
(ventilation) to eliminate unwanted
moisture, odors, grease, and chemicals**

Kitchens exhaust fans should have a duct that exhausts all the way to the outside of the house. You can usually see the duct inside the cabinet

Kitchens exhaust fans should be left on for 20 minutes after cooking to eliminate any smoke and other cooking chemicals



Many kitchens have an exhaust fan, but they often do a poor job of capturing smoke and odors from cooking

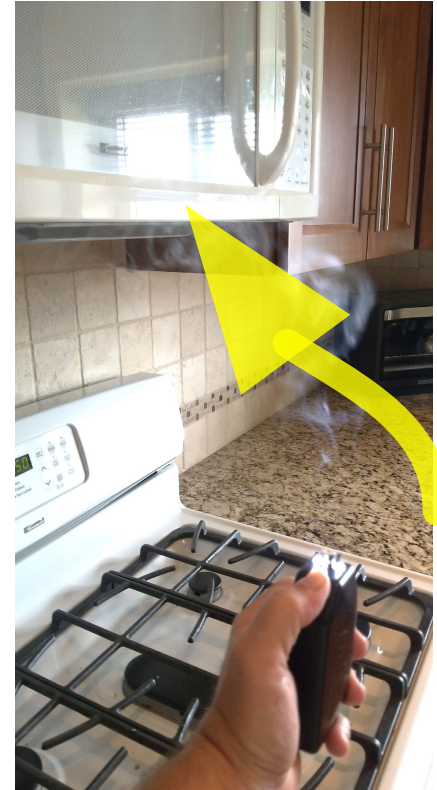
Exhaust hood
built into
microwave



Always test fan
to see if it
works and how
noisy it is



Vapor for testing



Capture Efficiency

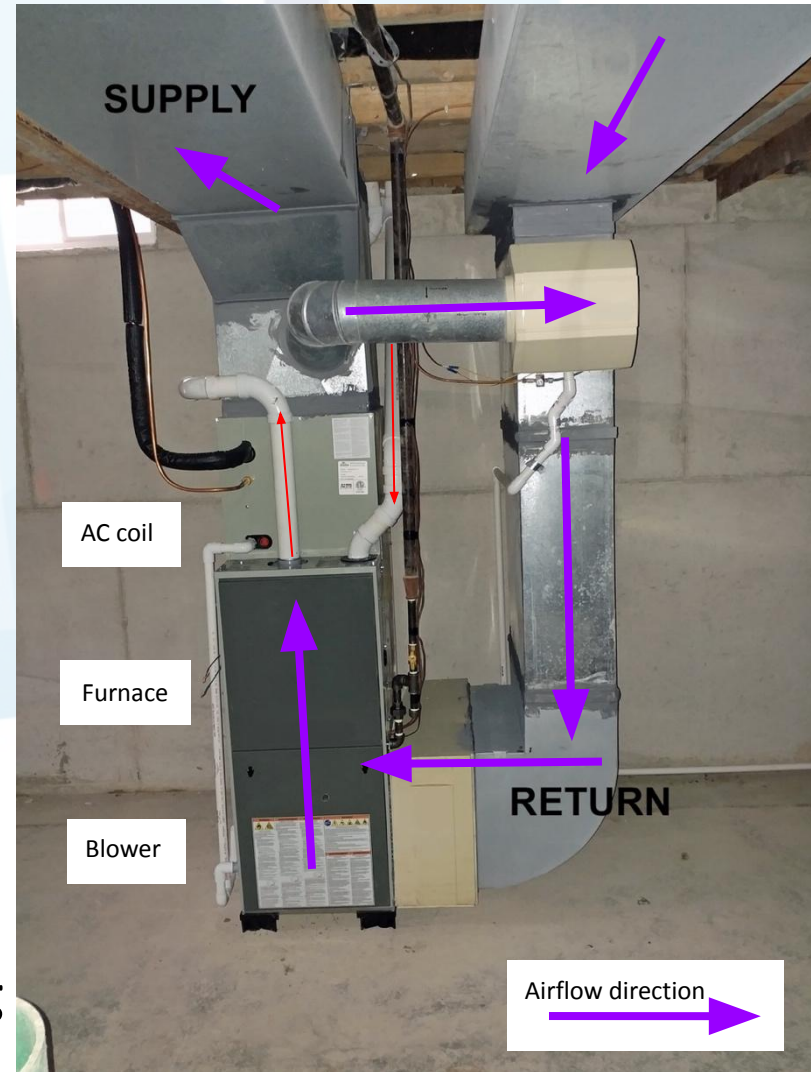
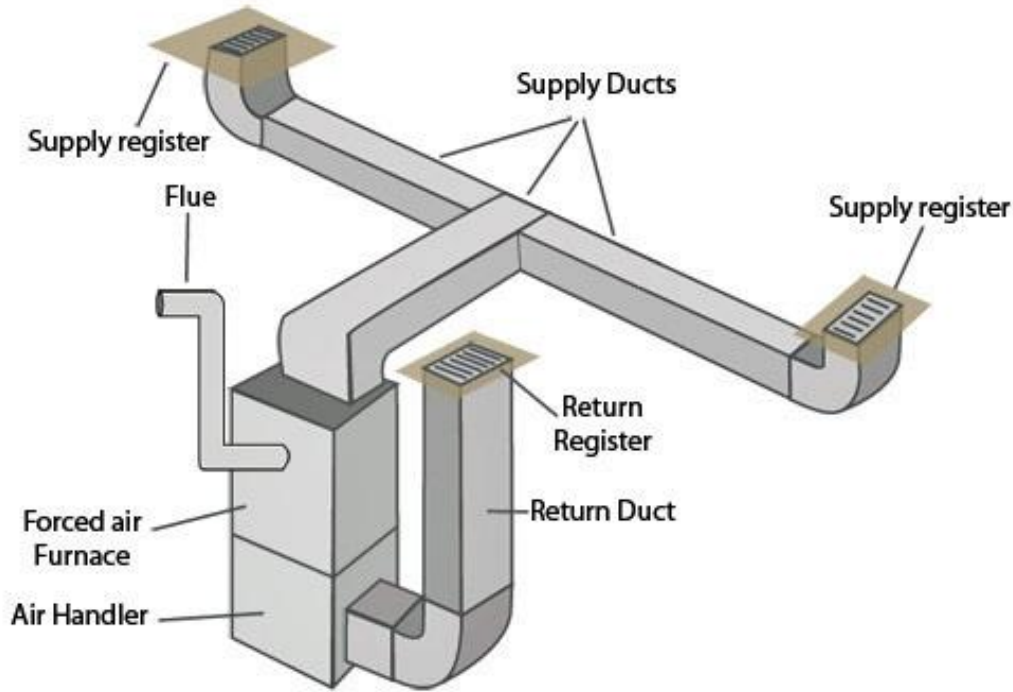


When visiting homes, look for both obvious and not so obvious indoor combustion sources

- Gas furnaces and water heaters
- Gas stoves and clothes dryers
- Gas/fuel space heaters
- Ventless heaters
- Candles and incense
- Other sources of smoke

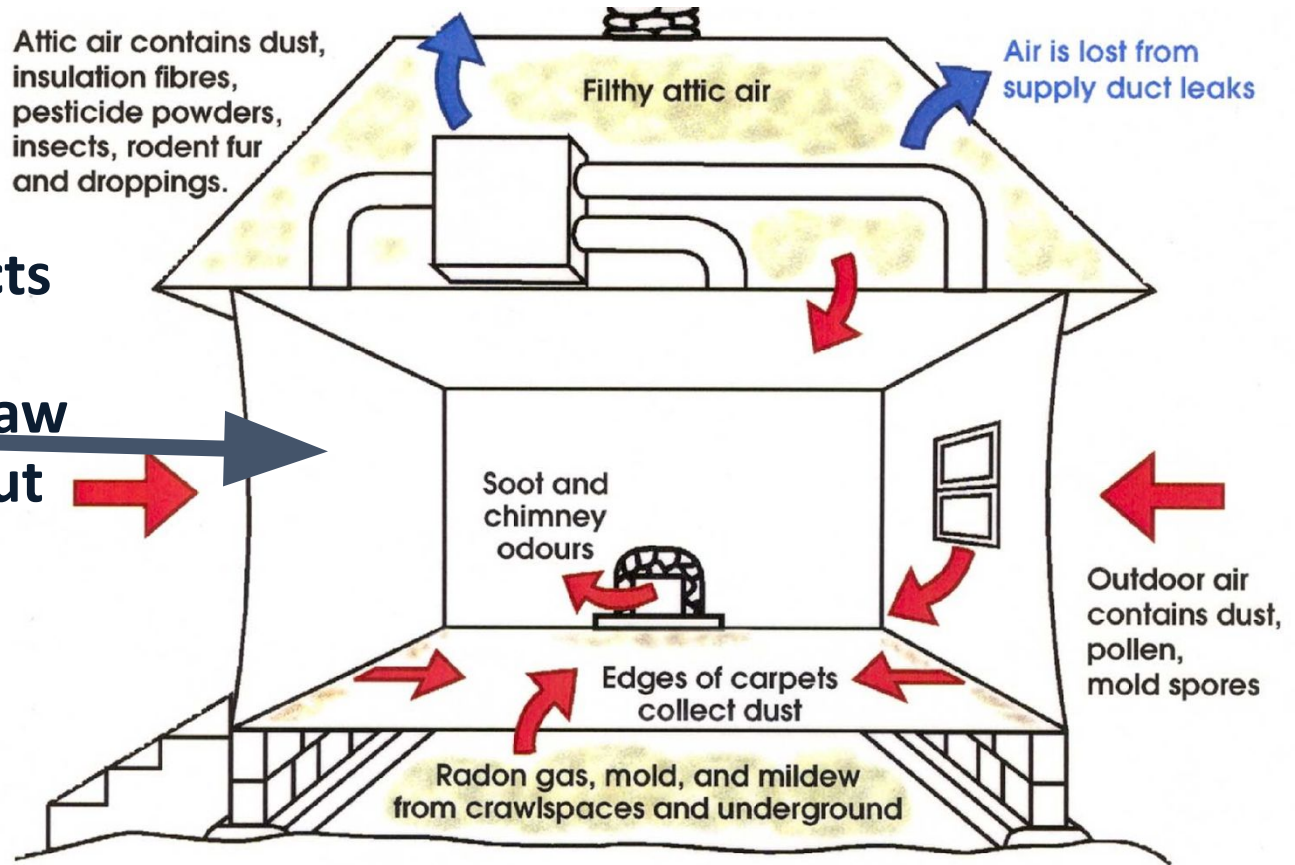


Forced air distribution is the most common HVAC system found in homes



HVAC = Heating Ventilation Air Conditioning

When air supply ducts leak into attics, the pressure changes draw air in and push air out bringing in dust



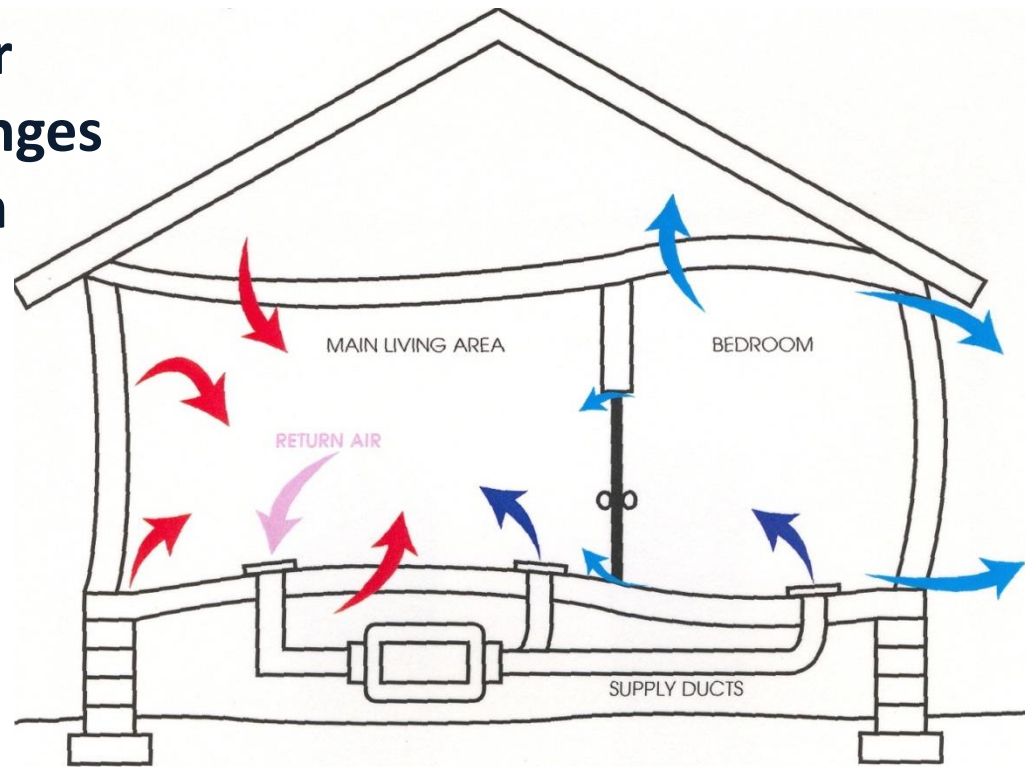
Supply Leaks "Depressurize" Your Entire House
(air going out must be replaced by air coming in)

From, "Healthy Home Guy", <https://www.healthyhomeguy.com>



In some houses, closing interior doors can lead to pressure changes that “unbalance” air circulation

- House has single central return vent
- Closed door ends up blocking return air
- Bedroom now has very positive pressure while living room is “starved” for air
- The “make-up” air is drawn from everywhere else



Symptoms indicating problem include uneven temperatures, excessively dry in winter, cold and clammy in the summer, dust staining around rug or carpet edges, smoky fireplaces and soot odors





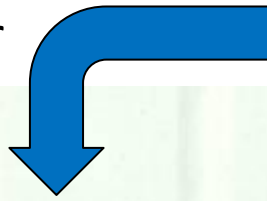
Healthy Indoors Training, LLC Lawrence, Kansas



Healthy Indoors Training, LLC Lawrence, Kansas

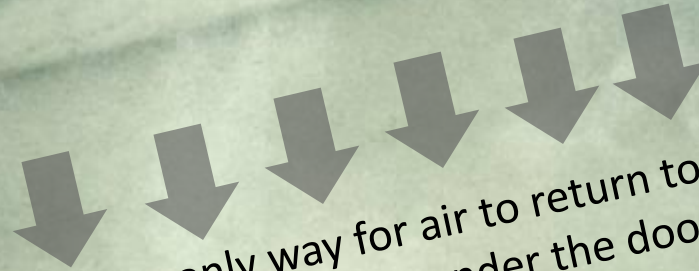
Supply air

from heating or cooling system



No Return
duct in the
room

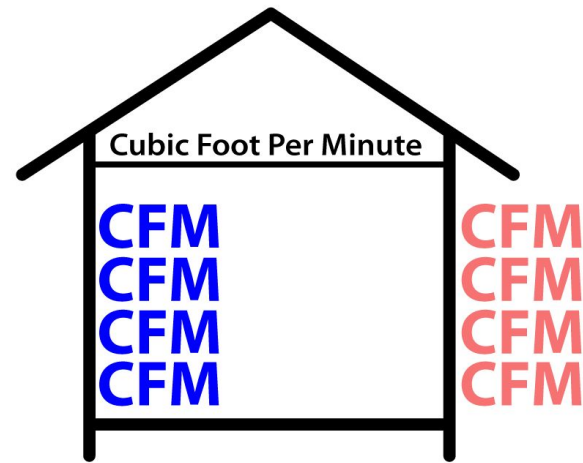
Air is blocked when door is closed



The only way for air to return to the
air handler is under the door.



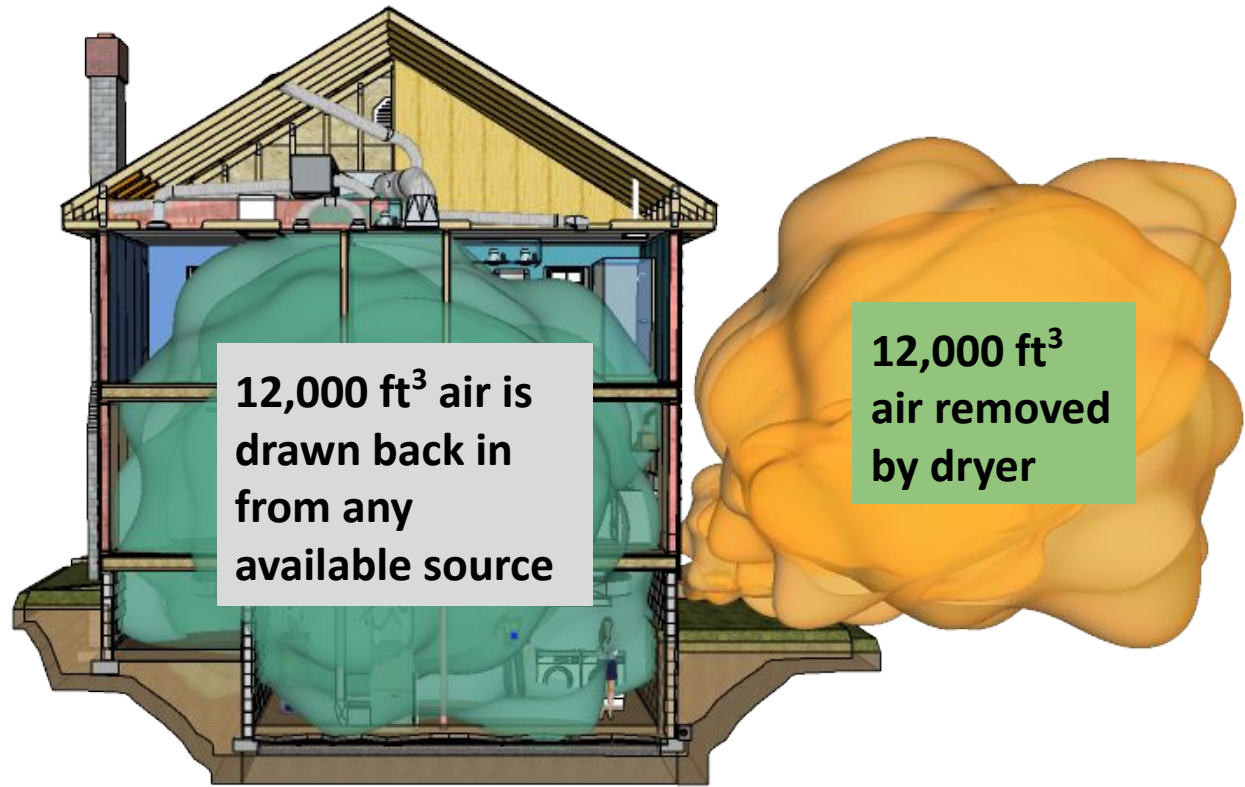
Fans - Represent a major driving force that can cause uncontrolled air infiltration



Device	CFM
Bath	50 -150
Range hood	150
Downdraft hood	400-600
“Emeril” Hood	1500
Dryer	200
Air Handler	400 / ton



Running your clothes dryer impacts air pressures and can enhance exposure pathways



Moisture removed **3 lbs (1.4 kg)**

Dryer 200 CFM (.024 M³/s) **12,000 ft³ (340 m³)**

Typical run time 60 min.

10' X 10' = 100 ft²
X 8' ceiling = 800 ft³

Illustration ©2018 Joe Medosch



Filters have a common rating system for determining their efficiency at removing particles from the air.

Minimum Efficiency Rating Value (MERV)

ASHRAE Standard 52.2
Testing General Ventilation
Air-cleaning Devices for
Removal Efficiency by
particle size

Filter Rating		10 to 3 microns	3.0 to 1.0 microns	1.0 to 0.3 microns	
MERV 1		< 20 %	< 20 %	< 20 %	Fiberglass & Aluminum Mesh Pollen, Dust Mites, Spray Paint, Carpet Fibres
MERV 2		< 20 %	< 20 %	< 20 %	
MERV 3		< 20 %	< 20 %	< 20 %	
MERV 4		< 20 %	< 20 %	< 20 %	
MERV 5		20 % - 34 %	< 20 %	< 20 %	Disposable Filters Mold Spores, Cooking Dusts, Hair Spray, Furniture Polish
MERV 6		35 % - 49 %	< 20 %	< 20 %	
MERV 7		50 % - 69 %	< 20 %	< 20 %	
MERV 8	FPR 5	70 % - 85 %	< 20 %	< 20 %	Box Filters Lead Dust, Flour, Auto Fumes, Welding Fumes
MERV 9		85 % or better	< 50 %	< 20 %	
MERV 10		85 % or better	50 % - 64 %	< 20 %	
MERV 11	FPR 7	85 % or better	65 % - 79 %	< 20 %	Commercial Filters Bacteria, Smoke, Sneezes
MERV 12		90 % or better	80 % - 90 %	< 20 %	
MERV 13	FPR 10	90 % or better	90 % or better	< 75 %	
MERV 14		90 % or better	90 % or better	75 % - 84 %	
MERV 15		90 % or better	95 % or better	85 % - 94 %	HEPA (High-Efficiency Particulate Air filter) & ULPA (Ultra Low Particulate Air filter) Viruses, Carbon Dust, <.30 pm
MERV 16		90 % or better	95 % or better	95 % or better	
MERV 17		99.97%	99 % or better	99 % or better	
MERV 18		99.997%	99 % or better	99 % or better	
MERV 19		99.9997%	99 % or better	99 % or better	
MERV 20		99.99997%	99 % or better	99 % or better	



HVAC filters have different MERV ratings based on how well they remove particles from the air



Common fiberglass filters (you can see through) have a MERV rating = 2



Pleated filters have folds. The more folds, the more surface area available for air to pass through. MERV rating = 8 to 13



High Efficiency Particulate Air (HEPA) Filtration

Is a standard for filters that indicates very high capture rate for fine and ultrafine particles

HEPA filters are used in

- Portable room air filtration units
- Some whole house heating and air conditioning systems

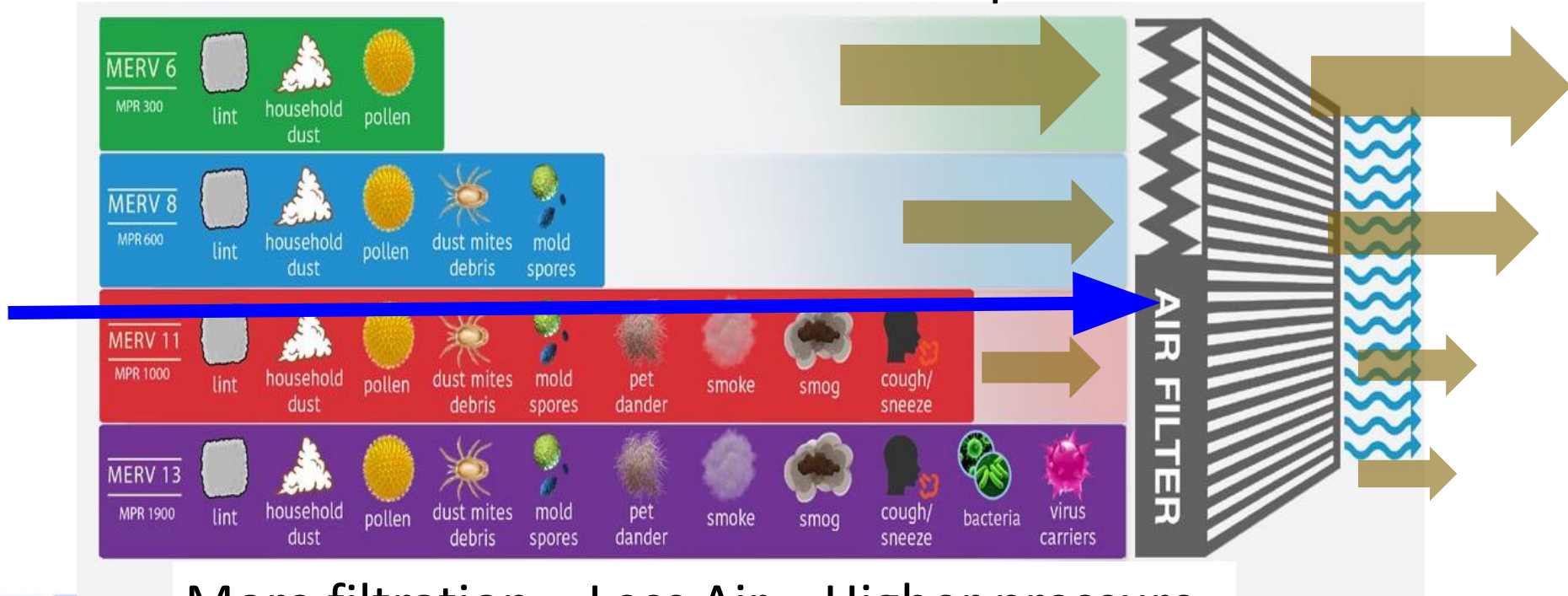


Many vacuum cleaners have HEPA filters on their exhaust to capture any particles



**When selecting replacement filters to offer clients,
weigh the benefits and costs for different MERV ratings**

Less filtration = More Air = Low pressure

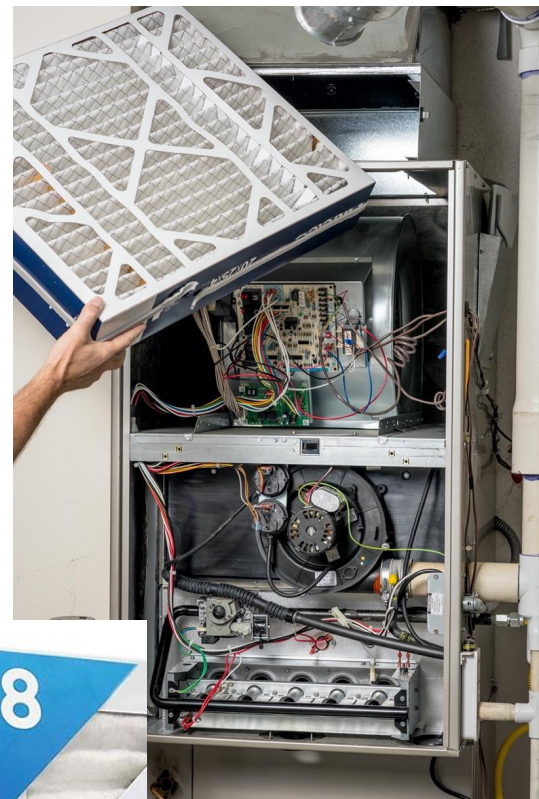


Before upgrading filters there are important things to consider

Higher rating does help filter out important particles and allergens from the air, but studies in actual homes show A LOT of variation.

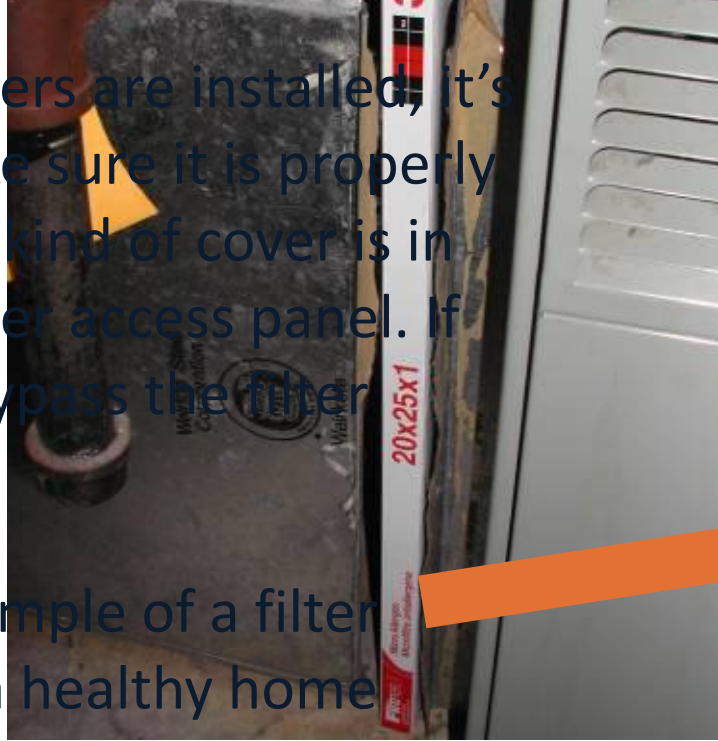
Factors to consider:

- Can system handle higher back pressure
- Actual system runtime per hour
- Properly sized and fitted seal
- Filter media and thickness



When furnace filters are installed, it's important to make sure it is properly seated and some kind of cover is in place over the filter access panel. If not, the air will bypass the filter making it useless

Here's an example of a filter provided by a healthy home program. Unfortunately, the filter provides no benefit



Exercise:

You're visiting the Johnson's home and ask about checking their furnace filter. They remove the panel and this is what they show you.

What issue do you observe?

What actions will you recommend?



Portable Room Air Cleaners

Portable room cleaners can work well for removing airborne particles, fibers, pollen, molds, allergens, smoke and debris.

- Cost = \$200 - \$1000
- Replacement Filters = \$50 - \$200
- Different models have combinations of pre-filters, charcoal filters, HEPA filters, and charged plates (ionizers)

Avoid Ionizers and electronic “purifiers”

But you must be careful when purchasing.
Not all devices work the same or as well.



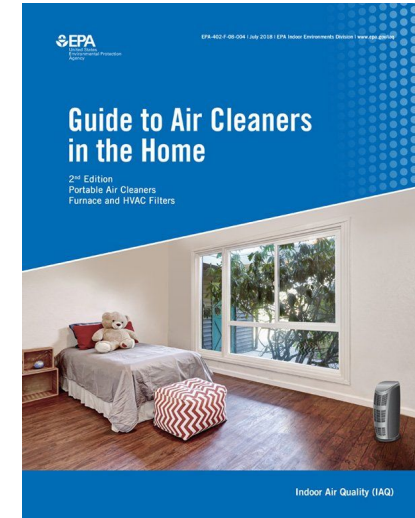
Portable Room Air Cleaners - Do your research

- Look for units that use HEPA filters
- Charcoal filters can be useful for odors
- Units must be placed away from walls and corners to be effective

Portable room filtration units should be purchased based on their **Clean Air Delivery Rate (CADR)** for smoke, dust and pollen. The CADR is based on the approximate area and volume of the room the device will work best in.

Download EPA guide_to_air_cleaners_in_the_home by clicking here-

https://www.dropbox.com/s/0zcvcf7zpau6qg3/guide_to_air_cleaners_in_the_home_2nd_edition.pdf?dl=1



Rated Voltage:	120V~
Rated Frequency:	60HZ
Rated Power:	45W
CADR(Smoke):	280CFM
CADR(Dust):	280CFM
CADR(Pollen):	280CFM
Noise:	29-53db

Here are some interesting ways to build your own simple portable room air filtration unit

- Can use one filter 1" thick or even 4" thick
- There are 1, 3 and 4 filter designs
- Studies show fan does not overheat when operated with filters attached



How to build a portable filtration unit: <https://www.youtube.com/watch?v=H2YELPNslmk>

Download DIY-Box-Fan-Evaluation Report-2021 by clicking here-

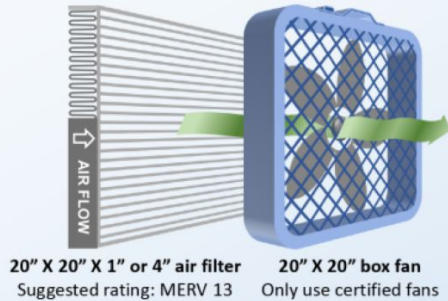
<https://www.dropbox.com/s/nw8keygtat8yewu/DIY-Box-Fan-Report-2021.pdf?dl=1>



Many organizations are offering summaries and designs, and new research about effectiveness of box fan filters

DIY Air Cleaner to Reduce Wildfire Smoke Indoors: Basic Design

Materials



20" X 20" X 1" or 4" air filter
Suggested rating: MERV 13

20" X 20" box fan
Only use certified fans with UL or ETL marking (2012 model or newer)



Clamps

or



Duct Tape

or



Bungee Cords

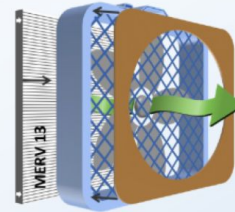
Assembly

1. Attach the air filter to the back of the box fan using either clamps, duct tape or bungee cords.
2. Check the filter for the direction of the air flow (marked on the side of the filter).
3. Replace filters when dirty.

Learn about box fan safety tips:

<https://www.epa.gov/air-research/research-diy-air-cleaners-reduce-wildfire-smoke-indoors#FAQ>

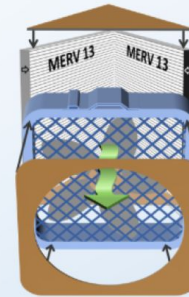
DIY Air Cleaner Designs: Beyond the Basic



Good

Basic Supplies:

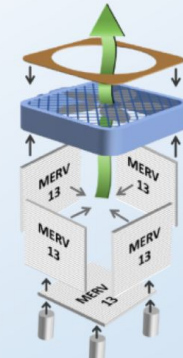
- 20" x 20" box fan
- 20" x 20" x 1" or 4" MERV 13 air filter
- 20" x 20" cardboard shroud (cutout the size of the fan blades)
- Clamps, duct tape, or bungee cords



Better

Additional Supplies:

- Two - MERV 13 air filters
- Triangle cardboard cutout for base on top



Best

Additional Supplies:

- Four or five - MERV 13 air filters
- If using five filter design, use leg supports (e.g., blocks) to allow airflow through bottom

Ways to Improve Effectiveness:

- Add a cardboard shroud (no-cost improvement)
- Use thicker filters (4" rather than 1" MERV 13 filters)
- Use multiple filters (2-5 filter designs)

Key Reminders:

- Only use certified fans with UL or ETL marking (2012 model or newer)
- Keep extra filters on hand
- Replace filters when dirty

This information is from EPA here:

<https://www.epa.gov/air-research/research-diy-air-cleaners-reduce-wildfire-smoke-indoors>

Exercise!: Apply your knowledge

You are visiting the Munson's home. Their daughter Sarah has asthma and is allergic to dust mites, cats and dogs.

- Work in small groups.
- Review the the photo of Jessica's bedroom
- Discuss possible sources of particles you observe in the room

Your breakout room number should match the group number on the exercise slide



Group #1 Exercise: This is the Sarah's Bedroom.

What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend
Stuffed animals	regularly wash them
Carpet	clean blinds use a hepa vacuum to regularly clean it
closed window open window will cause allergens to come in	cabinet blocking window
fan in front of bed-fan is very dusty	
stuffed animals eturn vent	Air purifier or a better fan that is able to attach a filter on it.
	Fan looks dirty
carpet	vacuum hepa filter or replace with wood floor



Group #2 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Group #3 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Group #4 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Group #5 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Group #6 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Group #7 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Group #8 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Group #9 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Group #10 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Group #11 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Group #12 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Group #13 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Group #14 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Group #15 Exercise: This is the Sarah's Bedroom.
What issues do you observe and what actions will you recommend?

Issues you observe	Action(s) you recommend



Healthy Home Assessment References & Resources Here:

<https://www.healthyindoortrainin.com/healthy-housing-resources>

Link to all public domain
resources used in class and
a whole lot more!



Healthy Home Assessment Resources ★

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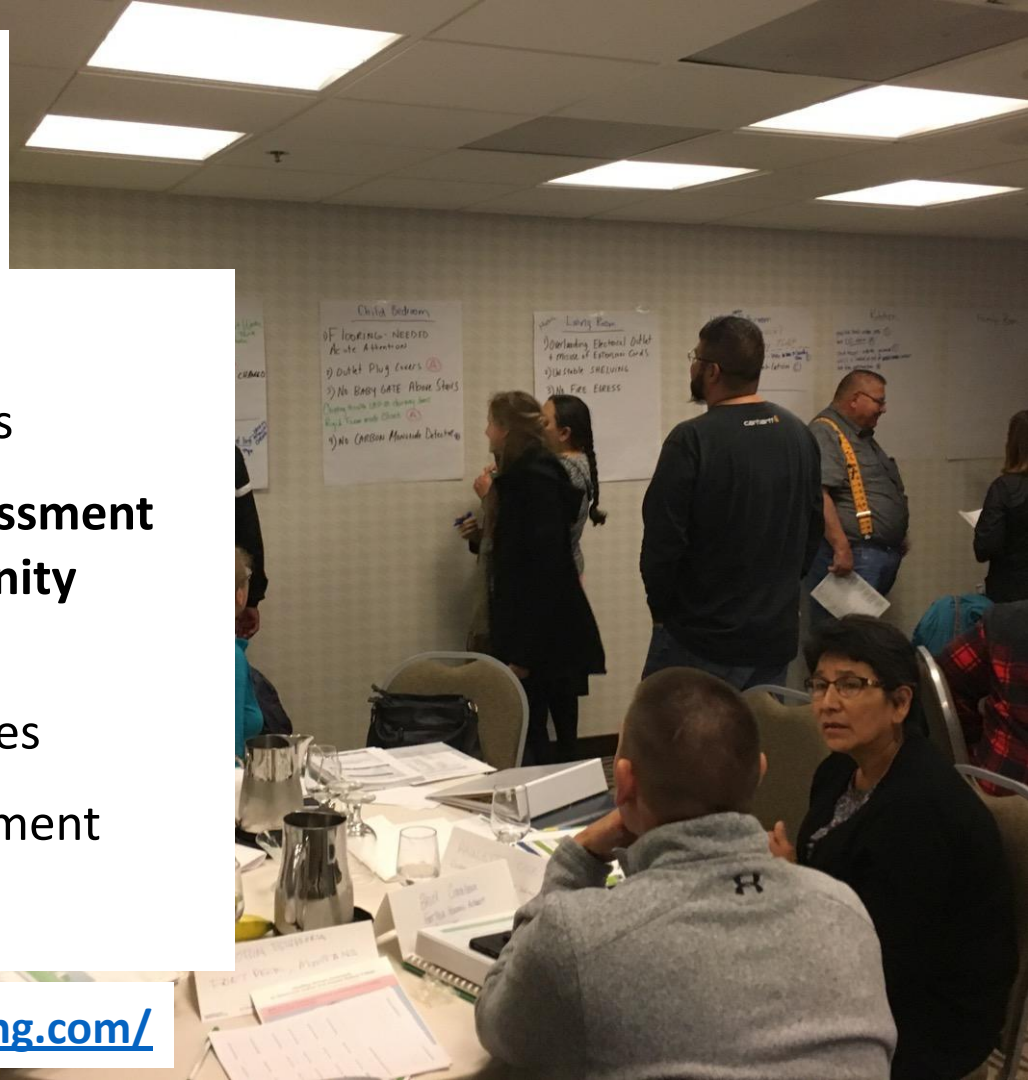
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I offer several Healthy Home Training courses

Available courses:

- One-day Healthy Housing Principles
- **Healthy Home Principles and Assessment Practice for Educators and Community Health Workers**
- Healthy Home Assessment Principles
- Advanced Environmental Measurement
- Healthy Home Evaluator

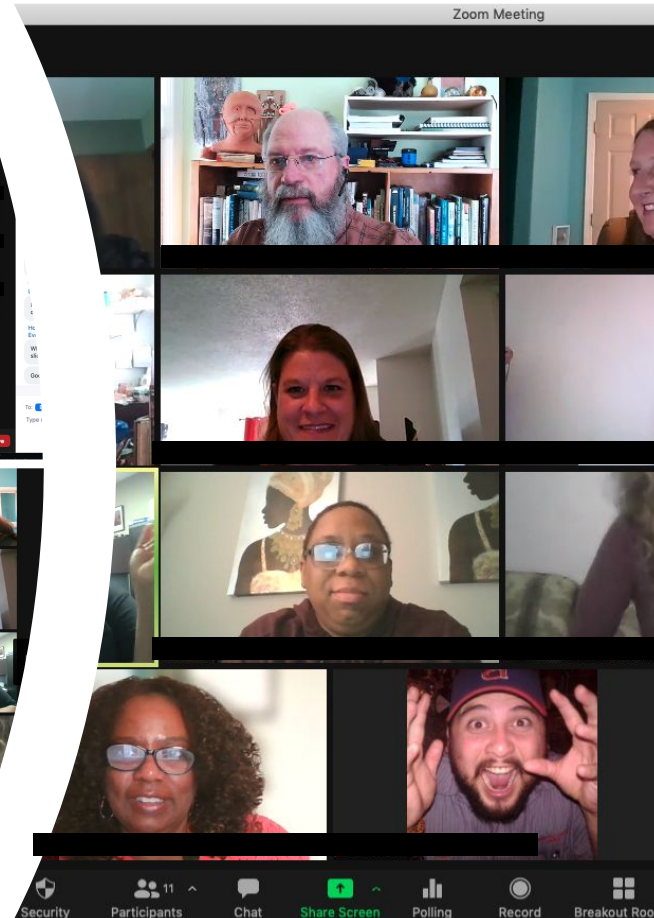
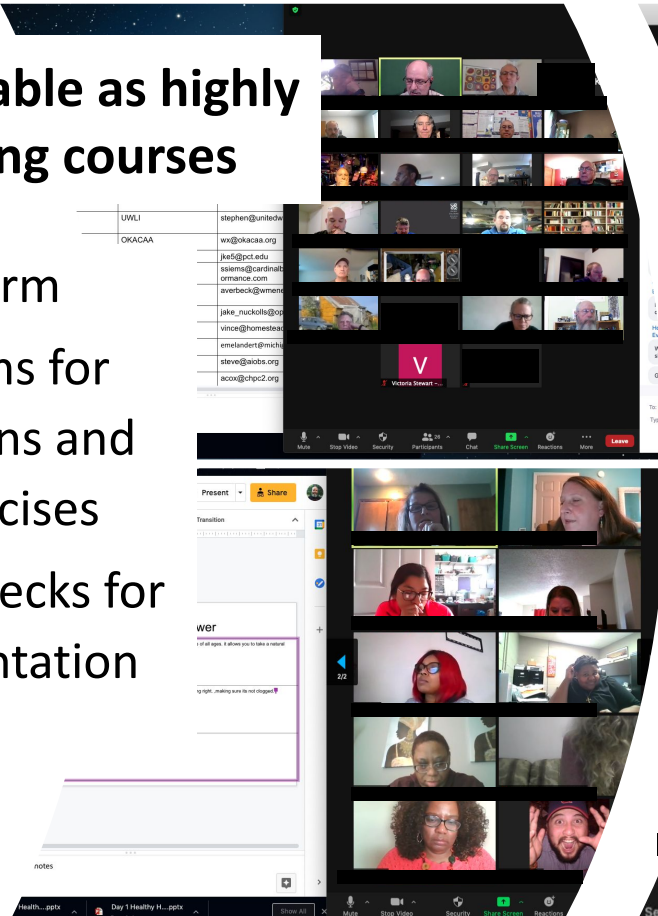


<https://www.healthyindoorstraining.com/>



All virtual courses available as highly interactive online training courses

- Zoom training platform
- Using breakout rooms for small group discussions and focused learning exercises
- Using Google slide decks for shared view of presentation slides and exercises



<https://www.healthyindoortraining.com/>



Questions?

Thank You!

Download a copy of the presentation by clicking this link:

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