Health Canada
First Nations and Inuit Health Branch
Environmental Public Health Services

Residential Indoor Air Quality

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Health Canada (HC) is the federal dept. responsible for helping the people of Canada maintain and improve their health.

First Nations Inuit Health (FNIH) supports the delivery of public health and health promotion services on-reserve and in Inuit communities.

Environmental Health Officers (EHOs)

- Prevent or identify environmental health risks that could threaten the health of the community
- Provide advice, guidance, education, public health inspections/investigations
- EHOs are employed by HC, some by First Nations and some by Tribal Councils
- Must be certified with the Canadian Institute of Public Health Inspectors - CPHI (C)
- Potential risks are identified and recommendations are made

Environmental Health Program

- Drinking Water
- Wastewater
- Communicable Disease Control
- Food Safety
- Solid Waste Disposal
- Emergency Preparedness and Response
- Housing
- Facilities Inspections
- Environmental Contaminants, Research and Risk Assessment

Today we hope to….

- Help communities identify the potential indoor air quality hazards in residential environments
- Discuss population at risk/potential health effects
- Brief overview of current standards and guidelines and methods to control exposure
- Review the effects of mould and IAQ in detail

Overview

Definition of Indoor Air Quality

Importance

Health risks

Sources

- indoor
- outdoor

Chemical and Biological Contaminants

Dampness and Ventilation

Managing Indoor Air Quality

What is Indoor Air Quality (IAQ)?

- Encompasses multiple agents and health issues
- Health impacts of IAQ are likely affected by quantity occupant density or people per room and quality of housing

"Air within domestic purposes should be sufficiently free from biological, physical, and chemical contaminants to ensure that there is a negligible risk to the health and safety of the occupants" (Health Canada)

What is Indoor Air Quality (IAQ)?

There is recent growing emphasis on RESIDENTIAL indoor air quality - WHY?

- ✓ tighter building construction
- ✓ presence of synthetic chemicals
- ✓ use of alternative heating systems
- ✓ recognition that prolonged exposure to chemical contaminants may result in toxic effects
- ✓ high proportion of the average individuals time is spent indoors

Characteristics of RESIDENTIAL housing that determines IAQ:

- type of ventilation
- frequency of air exchange
- characteristics of building materials
- maintenance of both the interior and the building envelope

Population at Risk?

- People can be at home for as much as 70% of their time
  - (this is generally higher for some segments of the population - very **young**, **elderly** and the **immunocompromised**)

- *A recent study shows Toronto residents spend 12 per cent of their time outdoors during a five-day work week in summer and only 2 per cent outdoors during a seven-day week in winter*

- *1 in 5 Canadians suffers from some form of respiratory ailment, such as asthma, bronchitis or allergic rhinitis*

Population at Risk?

1) ***Comfort and Prevention***

- largest group of people
- have no know reaction to low levels of contaminants
- need to improve comfort of the home and prevent health problems from occurring

Population at Risk?

2) ***Known Health Issues***

- includes persons with sensitivities
- includes allergies, respiratory ailments, and chemical sensitivities
- need to alter the home to lessen the effects of any known irritants

Population at Risk?

3) ***Serious Health Problems***

- a small percentage of population that are hypersensitive to numerous agents
- react adversely to low levels of exposure
- this group requires extraordinary measures to achieve such protection
- Guidelines/recommendations may not provide complete protection for the hypersensitive portion of the population – extraordinary measures needed

Sources of Residential Indoor Air Pollution

Health Canada has developed guidelines based on the potential adverse effects from long term exposures as well as short term exposures:

Exposure Guidelines for Residential Indoor Air Quality – A report of the Federal Provincial Advisory Committee on Environmental and Occupational Health (Revised July 1989)**

ASTER - Acceptable Long-Term Exposure Range (person may be exposed to over a lifetime without undue risk to health).

ALTER - Acceptable Short-Term Exposure Range (person may be exposed over the specified time period without undue risk to health).

***Mould (March 2007) and Formaldehyde (April 2006) were revised.*

Sources of Residential Indoor Air Pollution

(recommendations are expressed in terms of ranges of concentrations)

1st CATEGORY

- Aldehydes (total)
- **Formaldehyde**
- **Carbon Monoxide**
- **Carbon Dioxide**
- Ozone
- Nitrogen Dioxide
- Particulate Matter
- Water Vapour
- Sulphur Dioxide
- **Radon**

Sources of Residential Indoor Air Pollution

Contaminant	Acceptable short-term exposure range	Acceptable long-term exposure range
Carbon dioxide	—	≤3 500 ppm
Carbon monoxide	≤11 ppm (8 hours)	—
	≤25 ppm (1 hour)	
Formaldehyde	Action level: 120 µg/m³ (0.10 ppm) (Existing homes) Target level: 60 µg/m³ (0.05 ppm) (New homes)	
Nitrogen dioxide	≤0.25 ppm (1 hour)	≤0.05 ppm
Ozone	≤0.12 ppm (1hour)	—
Particulates	≤100 µg/m³ (1hour)	≤40µg/m³
Sulphur dioxide	≤0.38 ppm	≤0.019 ppm
Water vapour	30-80 per cent RH summer* 30-55 per cent RH winter**	
Radon	—	Action level is 800 Bq/m³ annual av. concentration in the living area

Legend: µg/m³—microgram per cubic metre
Bq/m³—Becquerel per cubic metre
ppm—Parts per million

*CMHC recommends that RH not exceed 60 per cent in basements in summer

** CMHC recommends that during the coldest periods, the indoor RH should be close to 30 per cent to avoid condensation

Table 1-A sample of Canadian residential exposure guidelines

Sources of Residential Indoor Air Pollution

Carbon Monoxide (CO)

- clear, odourless, tasteless gas - can cause death to occupant
- produced as a product of combustion
- sources in indoor air include gas and oil appliances, tobacco smoke, and infiltration of polluted outdoor air
- can be completely prevented with adequate ventilation
- insufficient design or lack of proper ventilation (coupled with indoor use of combustion appliances) increases the risks of CO poisoning

Sources of Residential Indoor Air Pollution

Carbon Monoxide (CO)

- Defects in gas appliances *e.g*. cracked heat exchanger in furnaces resulting in combustion gases mixing with heated return air.
- Backdrafting; winter homes become negatively pressurized (through dryer, bathroom vents, leaks)
- Regular mainatenance of fireplaces, wood stoves, chimneys, furnaces
- CO Detectors; always install location according to the manufacturers directions

Sources of Residential Indoor Air Pollution

Carbon Dioxide (CO_2)

- colourless, odourless non-flammable gas (used as an "indicator" of IAQ)
- produced by metabolic processes and by the combustion of fossil fuels
- indoor levels tend to be higher than outdoor levels
- gas stoves and improperly vented kerosene heaters are major sources
- poorly ventilated rooms may have levels that exceed recommendations due to human metabolism alone
- Headache, fatigue, unpleasant odours, stuffiness and undue warmth
- prolonged exposure causes serious health effects such as bone demineralization, effects on the CNS and cardiovascular effects

Sources of Residential Indoor Air Pollution - Radon

- Naturally occurring radioactive gas
- Colourless, odourless, tasteless
- Radon is “Heavy”
- Produced by decay of natural Uranium in soil and rocks
- Found in low concentrations everywhere outdoors
- Exposure to high levels increases risk of lung cancer

A Short History of Radon

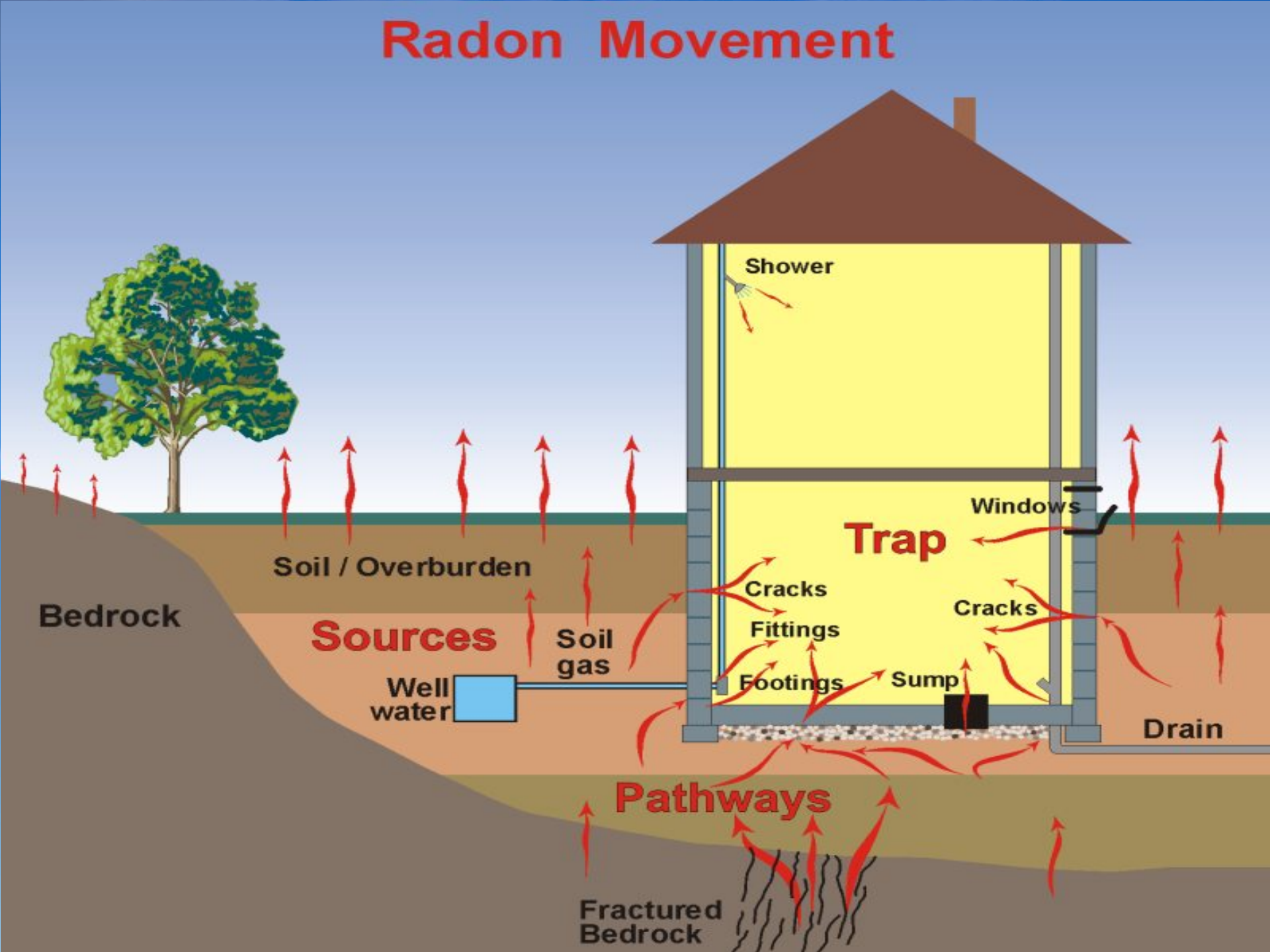
- Pitchblende (Uranium ore) first discovered in 1789 in Czech Republic
- Mined Pitchblende used to colour wood, leather, pottery and glass
- Over time, miners began dying of “Mountain Sickness”
- Illness blamed on dwarfs living in the mine

A Short History of Radon

- Health studies in the 1930s – 1940s began to link lung cancer in uranium mines with exposure to radon
- 1970s – 1980s residential radon begins to be studied

Radon Risk in the Home

- Exposure to residential radon depends on:
  - a source of radon in the ground
  - transportation into the home
  - restricted ventilation


Radon Movement
Shower
Windows
Trap
Soil / Overburden
Cracks
Cracks
Fittings
Bedrock
Sources
Soil gas
Well water
Footings
Sump
Drain
Pathways
Fractured Bedrock

Building Strategies to Reduce Radon

- Renovating basement floors and walls
- Sealing cracks and openings in walls, floors, around pipes and drains
- Ventilating the basement sub-floor

Radon Exposure

- 1988 – Health Canada guideline for radon exposure = 800 Becquerels per m^3
- 2007 – Health Canada's radon working group develops a new guideline of 200 Becquerels per m^3

Health Canada Guidelines

- Remedial measures should be undertaken in a dwelling whenever the average annual radon concentration exceeds 200 Bq/m^3 in the normal occupancy area.

- The higher the radon concentration, the sooner remedial measures should be undertaken.

- When remedial action is taken, the radon level should be reduced to a value as low as practicable.

- The construction of new dwellings should employ techniques that will minimize radon entry and will facilitate post-construction radon removal, should this subsequently prove necessary.

Sources of Residential Indoor Air Pollution

Formaldehyde (H_2CO)

- Sources influencing indoor levels – combustion and off-gassing
- Combustion (ETS, open fireplaces)
- Off-gassing (wood products, building materials made with adhesives, varnishes, paints, carpeting, drapes and curtains)
- Respiratory and allergic effects, increased risk of nasopharyngeal and sinonasal cancer in workers exposed to high levels
- Health Canada updated Residential Indoor Air Quality Guideline for Formaldehyde in April 2006.

Sources of Residential Indoor Air Pollution

(recommendations are practical measures used to reduce exposure)

2nd CATEGORY

- **Consumer Products**
  - Chlorinated Hydrocarbons
  - Pest Control Products
  - Product Aerosols
- Outdoor Air
- Fibrous Materials
- Lead (Outdoor Air)
- Polycyclic Aromatic Hydrocarbons
- **Environmental Tobacco Smoke (ETS)**

Sources of Residential Indoor Air Pollution

Consumer Products

Types:

- **Chlorinated Hydrocarbons** (solvents, cleansers, and aerosol propellants)
  - May be exposed to high levels in pursuit of hobbies
  - Absorbed into body – inhalation
- **Pest Control Products** (large number of diverse chemicals)
  - Used to control insects in home, treat house plants, treat pets and to disinfect air and surfaces around the home
  - May infiltrate from outdoor application
  - Exposure by inhalation and absorption
- **Product Aerosols**
  - Dispersed under pressure from disposable containers
  - Propellants include propane, butane and isobutane
  - Generally used in short duration and intermittent

Sources of Residential Indoor Air Pollution
Consumer Products Continued…

Examples:

- Painting and renovating
- Pesticide/Herbicide use
- Cleaning/disinfecting chemicals
- Detergents
- Perfumes
- Hair and body creams
- Work and hobbies
- Lifestyle practices

Control Measures:

- Ensuring adequate ventilation
- Ensuring that consumer observe any other precautionary statements prescribed on the product label/instructions
- Pest control products used when absolutely necessary
- Ensure use of personal protective equipment

Sources of Residential Indoor Air Pollution
Environmental Tobacco Smoke (ETS)

- Combination of poisonous gases, liquids and breathable particles
- Consists of mainstream smoke, the smoke inhaled and exhaled by the smoker AND sidestream smoke, the smoke released directly from the end of a burning cigarette
- Contains over 4000 chemicals (50 cause cancer)
- 2/3 of smoke is not inhaled by smoker but released into the surrounding environment
- Only 3 in 10 people report being exposed to second hand smoke, 9 in 10 people have detectable levels in their bodies
- MAJOR SOURCE of indoor air pollution

US EPA "estimates the risk of developing cancer from exposure to second-hand smoke is about 57 times greater than the total risk posed by all outdoor air contaminants"

Sources of Residential Indoor Air Pollution Environmental Tobacco Smoke (ETS) cont…

- Causes eye, nose and throat irritation, headaches, dizziness, nausea, coughing and wheezing
- In young children – chronic respiratory illness, impaired lung function and middle ear infections
- Can retard growth and development of fetuses
- Aggravate symptoms in people with allergies or asthma
- Long term exposure has been linked to heart disease and cancer

Sources of Residential Indoor Air Pollution

Environmental Tobacco Smoke (ETS) cont…

The First Nations and Inuit Health Branch of Health Canada reports the following facts on smoking rates in First Nations and Inuit communities:

- **60%** of on-reserve First Nations people between the ages of 18 and 34 currently smoke;
- **70%** of Inuit in the north between the ages of 18 and 45 currently smoke;
- Almost half of Inuit (46%) who smoke started smoking at age 14 or younger; and
- The majority of on-reserve First Nations people who smoke (52%) started smoking between the ages of 13 and 16.

These statistics are from the 2004 Baseline Study among First Nations On-reserve and Inuit in the North, Environics Research Group.

Sources of Residential Indoor Air Pollution Environmental Tobacco Smoke (ETS) cont…

Controls:

- Increasing ventilation will dilute the smoke – but will NOT make it safe
- Restricting smokers to separate rooms will only work if these rooms have their own ventilation systems.
- Electronic air filters and air “purifiers” may remove some smoke particles from the air but they CANNOT remove those that have settled on the food, furnishing, skin and other surfaces
- **There is only one way to eliminate ETS from indoor air – REMOVE THE SOURCE**

Sources of Residential Indoor Air Pollution

Biological Contaminants

Types:

- Mould
- Microorganisms (humans, pets, insects, growth on surfaces or stagnant water)
- Bioaerosols (moulds, bacteria)
- Dust (pollens, spores, cells, cell debris, insects)

Control Measures:

- Excess humidity and condensation are not present
- Surfaces are kept free from dust (disinfection and physical removal of the agent where possible)
- Stagnant water sources, such as humidifier tanks are kept clean and disinfected

Sources of Residential Indoor Air Pollution

Biological Contaminants

Mice: droppings, urine, nests may harbour hantavirus
Hantavirus Pulmonary Syndrome

Pigeons: droppings, nets may harbour
Histoplasma capsulatum
Cryptococcus neoformans
Clamydia psittaci

House Dust: pets (dander, saliva), dust mites (feces, chitin)

Sources of Residential Indoor Air Pollution

Biological Agents

Mould

- Microscopic fungi grow into visible colonies

Mildew

- often used term applied to mould, powdery mildew

Yeasts

- beer, wine, bread

Mushrooms

- Portobello, shitake

Sources of Residential Indoor Air Pollution

Mould Growth

Moisture to allow growth and digestion to take place RH>60%

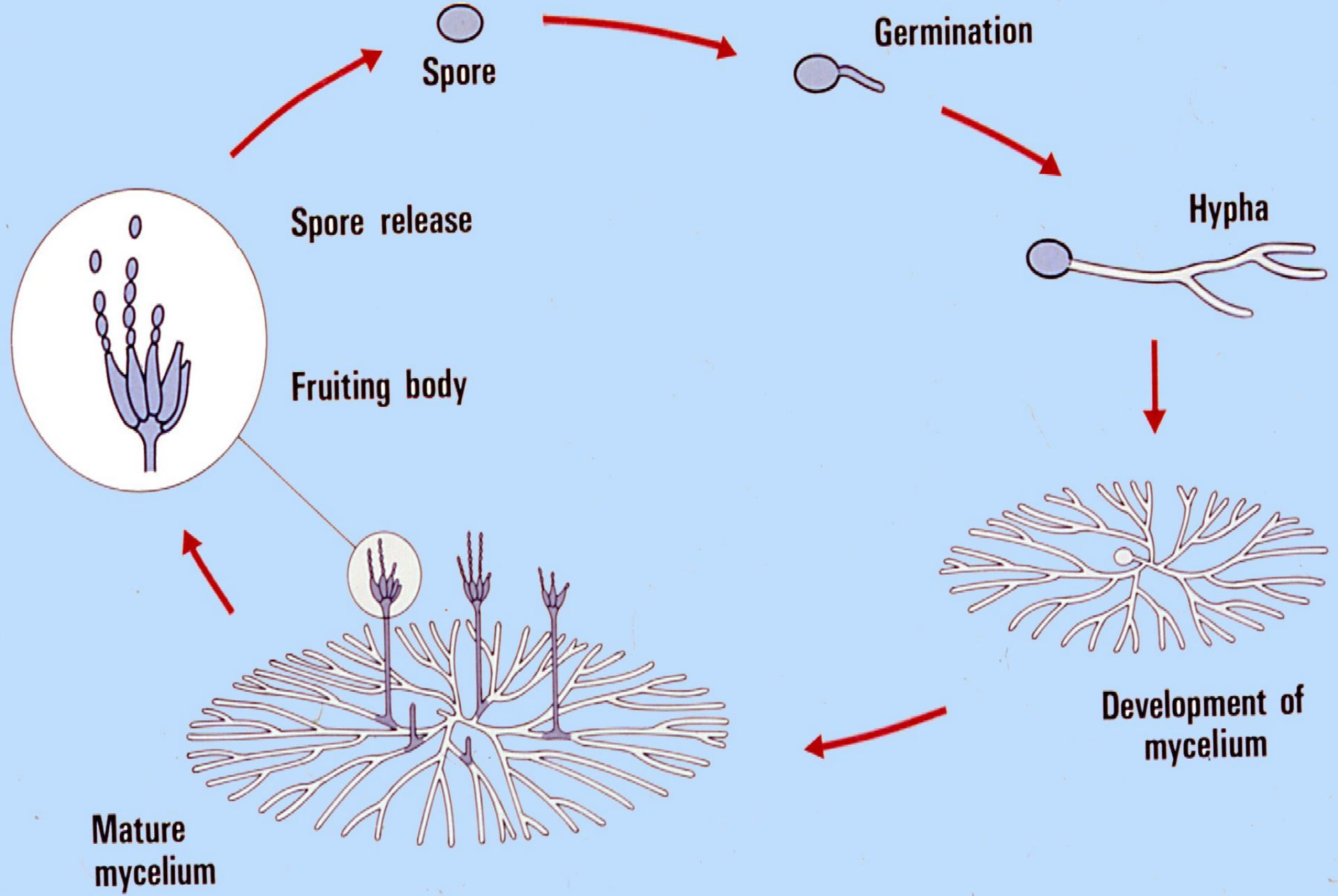
Food source (organic materials)

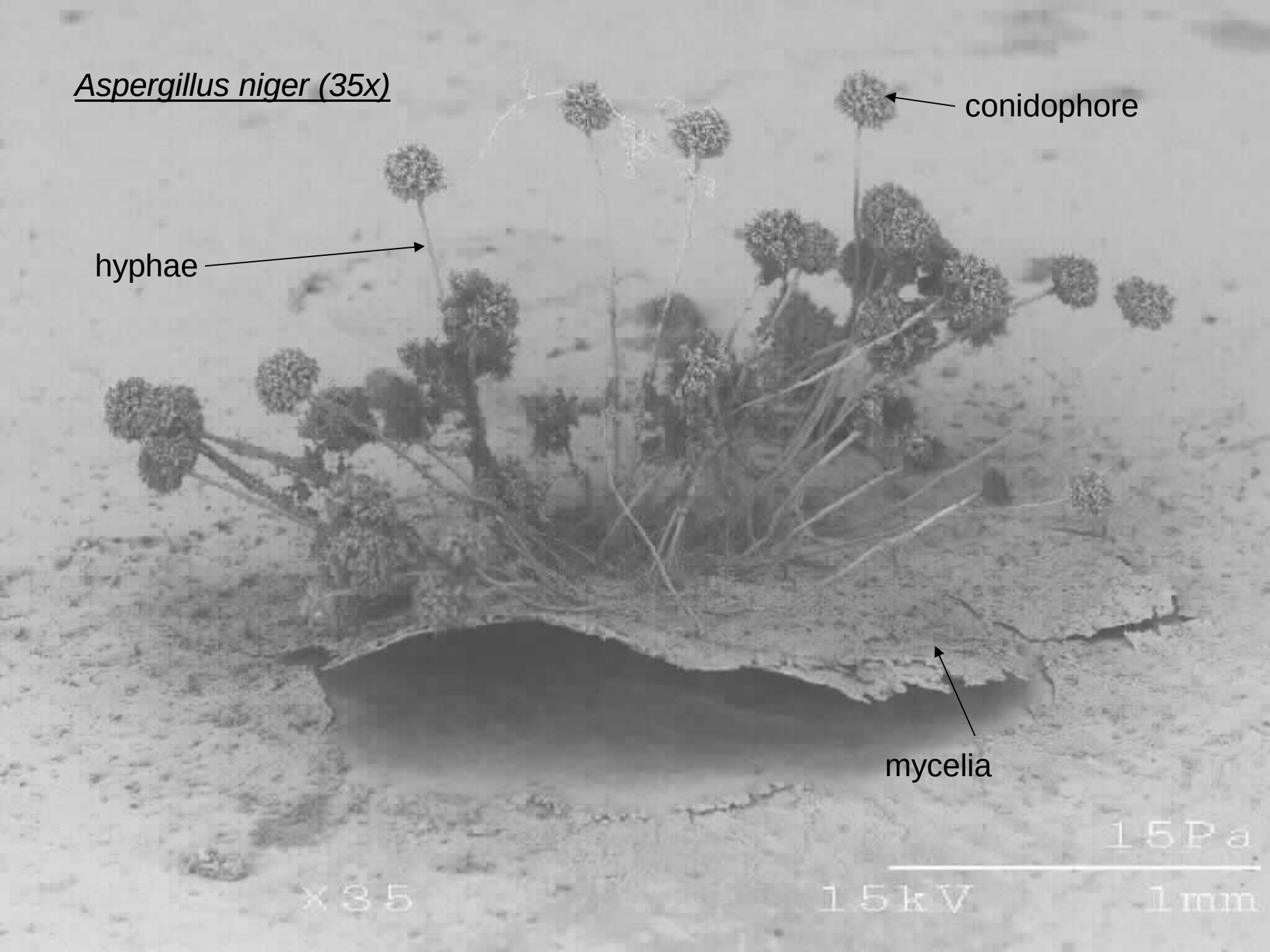
Suitable temperature range and oxygen

Moulds reproduce by releasing spores

- Spores become airborne or transported (house dust), everywhere, long-lived and resistant to stress

Schematic life cycle of a mould fungus




Aspergillus niger (35x)
conidophore
hyphae
mycelia
15Pa
x35
15kV
1mm

Sources of Residential Indoor Air Pollution

Moud Health Effects

Immunological effects: Inhalation of spores or hyphae.

Allergic reactions, runny nose, eye irritation, cough, congestion, wheezing

Aggravation of asthma hypersentsitivity Pneumonitis

Toxic effects: Inhalation of metabolites (mycotoxins, mVOC's)

Fatigue, nausea, headaches, respiratory and eye irritations

Infectious disease: Inhalation of spores

Histoplasmosis - Bird and bat droppings

Blastomycosis – Undisturbed acidic moist soils

Sources of Residential Indoor Air Pollution

Moud Health Effects

Health-based exposure limits for indoor mould in residential environments have not been established;

Removing sites of visible and hidden mould and repairing and controlling sources excessive moisture is the best approach to controlling health risks.

Mould Problems are Caused by Moisture Problems

Unless the moisture source is corrected, mould will continue to grow

Moisture accumulation or damage is a precursor to growth

Moisture accumulation mechanism must be corrected

Moisture accumulation can be a function of the house (design, construction or repair), or its operation

Moisture Sources
Structural

Surface water penetration through building envelope:

- Roof
- Flashing
- Windows
- Foundation (walls, capillary wicking, weeping tile)
- Lack of eves-troughs

Water damage through plumbing leaks

Moisture Sources
Occupant Generated

Moisture accumulation/damage to structure through lack of ventilation:

- Respiration and perspiring (1-2 L/d)
- Cooking (1 L/h)
- Showering (2 L/h)
- Drying Laundry (4 kg of laundry from the washer after spin cycle can retain 3 L water)

Released through leak in vent, or indoor drying.


ROOM
116

Residential Indoor Air Quality

Dampness and Ventilation

Encompasses all aspect of IAQ

Relative Humidity: 60% in summer, 30% in winter

Carbon Dioxide: not >1000 ppm

Temperature: 20C or 70F

Ventilation: - 1500 sqf 3 bedroom home = 21 L/sec

- bathroom fan 25 L/s


shop-vac
HEADBOARD
COVERS

Residential Indoor Air Quality
Dampness and Ventilation

Maintaining Heat and Air Flow

- Reduce clutter
- Move furniture away from walls 3-4”
- Bathroom vents clean, ensure flow rate, sealed ducting to the outside
- Windows are much colder than adjacent walls
  - thermo-plastic barrier in winter (shrink-film)
- Ensure adequate caulking and insulation around doors, windows

Residential Indoor Air Quality
Simple Control Methods

Most IAQ problems can be prevented with good maintenance, and resolved with simple and inexpensive measures.

Residential Indoor Air Quality
Simple Control Methods

Reduce clutter (shelving, outdoor storage)

Minimize dust build-up (sweep, vacuum – HEPA, avoid carpets, laundry vent)

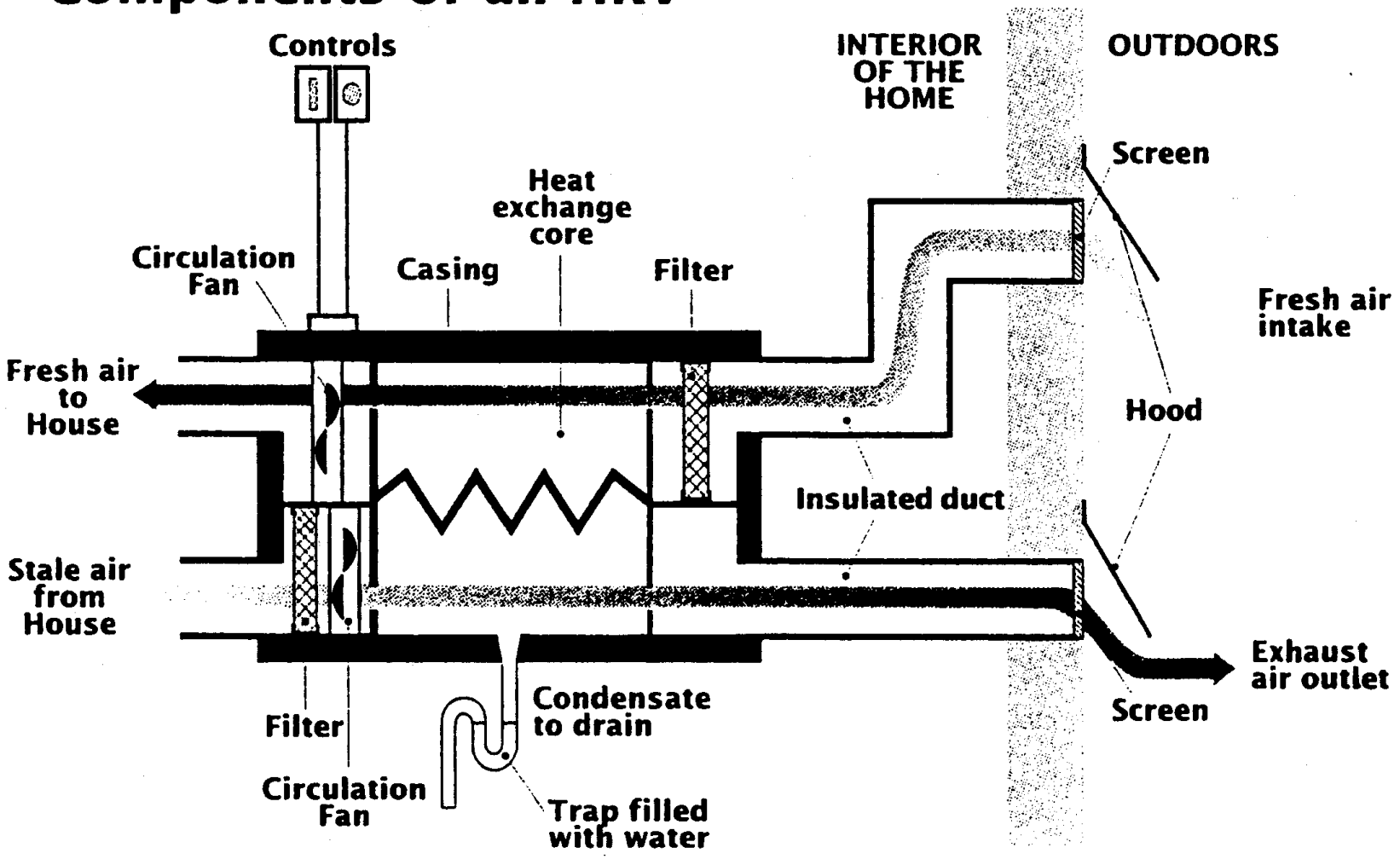
Windows, roof, envelope

Crawlspace, basement – finished, framed insulated

Furnishings

Cleaners, personal care products

Components of an HRV



(Note: All the parts shown here may not be found on all HRVs)

Residential Indoor Air Quality

Heat Recovery Ventilators

Insulated ducts for incoming (fresh) and outgoing (stale) air.

Ductwork distribute fresh air throughout the house, and to return stale air to the HRV.

Fans circulate the fresh air through the house and to exhaust stale air to the outside.

A heat exchange core where heat is transferred from one air stream to another.

Residential Indoor Air Quality

Heat Recovery Ventilators

HRV: - brings in fresh air, cleans it, exhausts stale

- minimizes heating or cooling loss,
  - winter captures outgoing heat
  - summer (AC) captures outgoing cool air
  - summer (no ac) just dehumidify
- simple maintenance
  - cleaning intake and exhaust plenums,
  - wash filters, remove dust from fan,
  - follow instruction manual

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Thank you