

National Collaborating Centre for Environmental Health

Mould: Health Effects, Exposure Assessment and Remediation

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National Collaborating Centre
for Environmental Health

Centre de collaboration nationale
en santé environnementale



BC Centre for Disease Control
An agency of the Provincial Health Services Authority

Outline

- What is mould?
- What are the health effects ascribed to mould?
- What is the evidence for these health effects?
- How do you know if you have a mould problem?
- What do you do if there is a mould problem?

Mould and Health Effects

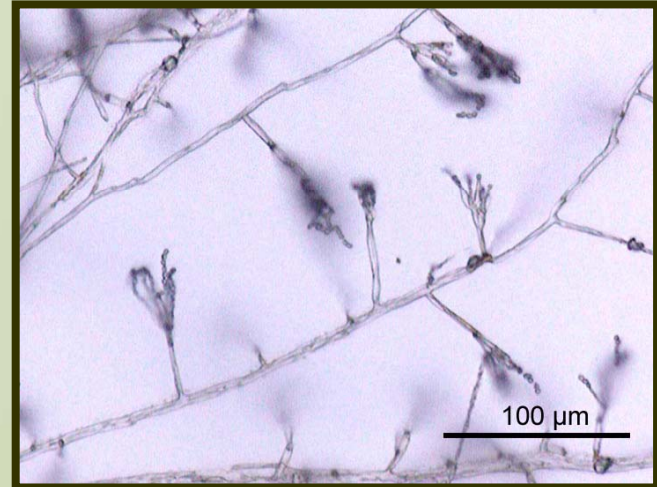
Objectives

- To update state of knowledge about mould in indoor environments and health effects since the IOM's Damp Indoor Spaces and Health (2004)
- To make recommendations for mould testing and remediation

What is mould?

- Eukaryotic, microscopic, spore-bearing (except yeasts)
- Separate phylogeny from plants and animals
- Grows in mat of intertwined filaments (hyphae)
- Relies on dead or decaying organic matter

Photos: <http://en.wikipedia.org/wiki/Hypha>



What does mould need to grow?

- Food (organic matter)
- Right temperature (preferably 18-32°C)
- Water

Only component in indoors that can be controlled is water

What are the components of concern?

- Mycotoxins
- Spores
- Structural components
- Volatile organic compounds

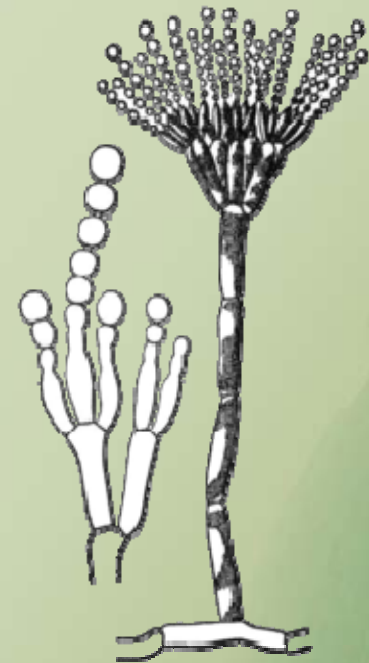


Photo: <http://en.wikipedia.org/wiki/Hypha>

How can I get exposed?

- Ingestion
- Dermal contact
- Inhalation

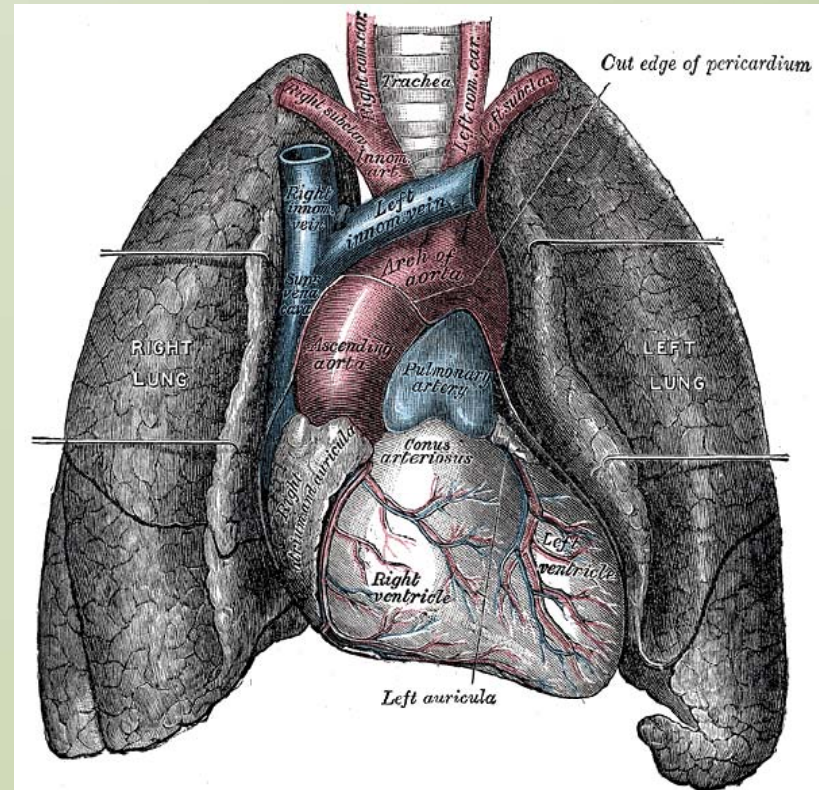


Photo: <http://commons.wikimedia.org/wiki/File:Heart-and-lungs.jpg>

What are the types of ascribed health effects?

- Systemic fungal infections
- Allergic reactions
- Irritant/non-allergic reactions
- Toxic effects

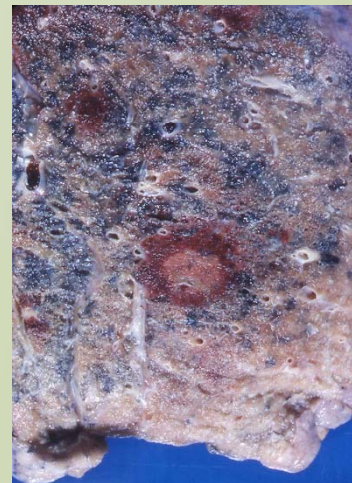


Photo:<http://www.flickr.com/photos/haiiroproject/3947206219/>

Ascribed Health Effects

Range of health effects blamed on mould exposure:

- Lower, upper respiratory effects
- Asthma
- Respiratory tract disorders
- Pulmonary hemorrhage
- Neurological, reproductive, immune effects
- Cancer

Photo: <http://upload.wikimedia.org/wikipedia/commons/d/d3/Aspergillois.jpg>

Methodology for Reviewing Evidence for Health Effects

Looked at guidelines, position papers, reviews and metaanalyses where most

- were written by subject area experts or were reviewed by a committee of experts in the field;
- critically evaluated the research that has been done in the field, taking into account limitations;
- were either endorsed by a professional or scientific body, or published in peer-reviewed journals.

Key

++	Sufficient evidence of a causal relationship
+	Sufficient evidence of an association
(-)	Limited or suggestive evidence of an association
0	Inadequate or insufficient evidence to determine whether an association exists
	Association not examined (blank)

Evidence for Health Effects

Study	Agent of Interest	Asthma symptoms	Asthma development	Allergy /hyper-sensitivity	Upper respiratory	Lower respiratory	General /toxic effects
IOM (2004)	Indoor Mould	+	0		+	(-)	0
Storey et al. (2004)	Indoor Mould						0
Curtis (2004)	Indoor mould, mycotoxin						*
Douwes (2005)	Beta 1,3 glucan			0	0		0

*regarded IOM study as benchmark

Evidence for Health Effects

Study	Agent of Interest	Asthma Symptoms	Asthma Development	Allergy Hyper-sensitivity	Upper Respiratory	Lower Respiratory	General /Toxic Effects
Richardson et al. (2005)	Dust mite allergen	+					
Richardson et al., (2005)	Other agents incl. mould	0					
AAAAI, Bush et al. (2006)	Indoor mould	0	0	+	0		0
Committee on Environmental Health (2006)	Indoor mould	+	0	+	+	0	0
Mazur et al. (2006)	Indoor dampness and mould	+		+			+
Fisk et al. (2007)	Indoor dampness and mould	+	(-)		+		

Evidence for Health Effects

Study	Agent of Interest	Asthma Symptoms	Asthma Development	Allergy /Hyper-sensitivity	Upper Respiratory	Lower Respiratory	General /Toxic Effects
Mudarri and Fisk (2007)	Indoor dampness and mould	+	(-)		+		
Health Canada (2007)	Indoor mould	+					
Seltzer and Fedoruk (2007)	Indoor mould	+	0	0	+	(-)	0
Hope and Simon (2007)	Indoor dampness and mould				+		
Dales et al. (2008)	Indoor air (many factors)				+		
Sahakian et al. (2008)	Indoor dampness and mould	+	+		+	+	

Evidence for Health Effects

Study	Agent of Interest	Asthma Symptoms	Asthma Development	Allergy /Hyper-sensitivity	Upper Respiratory	Lower Respiratory	General /Toxic Effects
NYC (2008)	Indoor damp	+		+	+		0
Portnoy et al. (2008)	Indoor mould	+	0	+			
Pestka et al. (2008)	Stachy-botrys & bioactive components	0	0				
Bush (2008)	Indoor allergens including mould	+		+			

Summary of Evidence for Health Effects from Indoor Mould Exposure

- Causal relationship
 - None
- Sufficient evidence for association
 - Asthma symptoms (in asthmatics)
 - Upper respiratory symptoms (i.e., sore throat, conjunctivitis, allergic rhinitis, nasal symptoms)
 - Cough, wheeze
 - Hypersensitivity pneumonitis in susceptible people

Summary of Evidence Cont'd

- Limited or suggestive evidence for association
 - Lower respiratory tract symptoms in otherwise healthy children
- Inadequate or insufficient evidence for association
 - Asthma development (although more evidence is accumulating)
 - Other respiratory disease not mentioned above
 - GI tract problems
 - Skin symptoms
 - Non-occupational inhalation fevers
 - Neuropsychiatric symptoms
 - Cancer
 - Rheumatologic and other immune diseases
 - Reproductive effects
 - Acute idiopathic pulmonary hemorrhage in infants.

How do you know if you have a mould problem?

Visual inspection most important

- Signs of water intrusion
- Building envelope
- Sometimes not visual
- Testing can supplement

AIHA “Green Book” – Recognition, Evaluation, and Control of Indoor Mold (2008)



Photo:

http://images.google.ca/imgres?imgurl=http://coastalhomeinspections.org/mold_house.jpg&imgrefurl=http://coastalhomeinspections.org/services.html&usg=__e6NGopW6nTFTtN0FbMQU4yCLRE=&h=311&w=400&sz=46&hl=en&start=22&um=1&tbnid=kRd4U8bILXAD_M:&tbnh=96&tbnw=124&prev=/images%3Fq%3Dmold%2Btesting%2Bphotos%26ndsp%3D20%26hl%3Den%26sa%3DN%26start%3D20%26um%3D1

Visible mould or suspicion of mould: odour, water damage, excess moisture or health effects.

STEP 1 INFORMATION GATHERING & PLANNING BY PHI OR EHO

Gather information about complaints, space and occupants use.

STEP 2 VISUAL INSPECTION OF PREMISES BY PHI OR EHO

Examination of external and internal surfaces for signs of moisture damage and mould growth.

Unclear if mould or moisture is present

No further action required

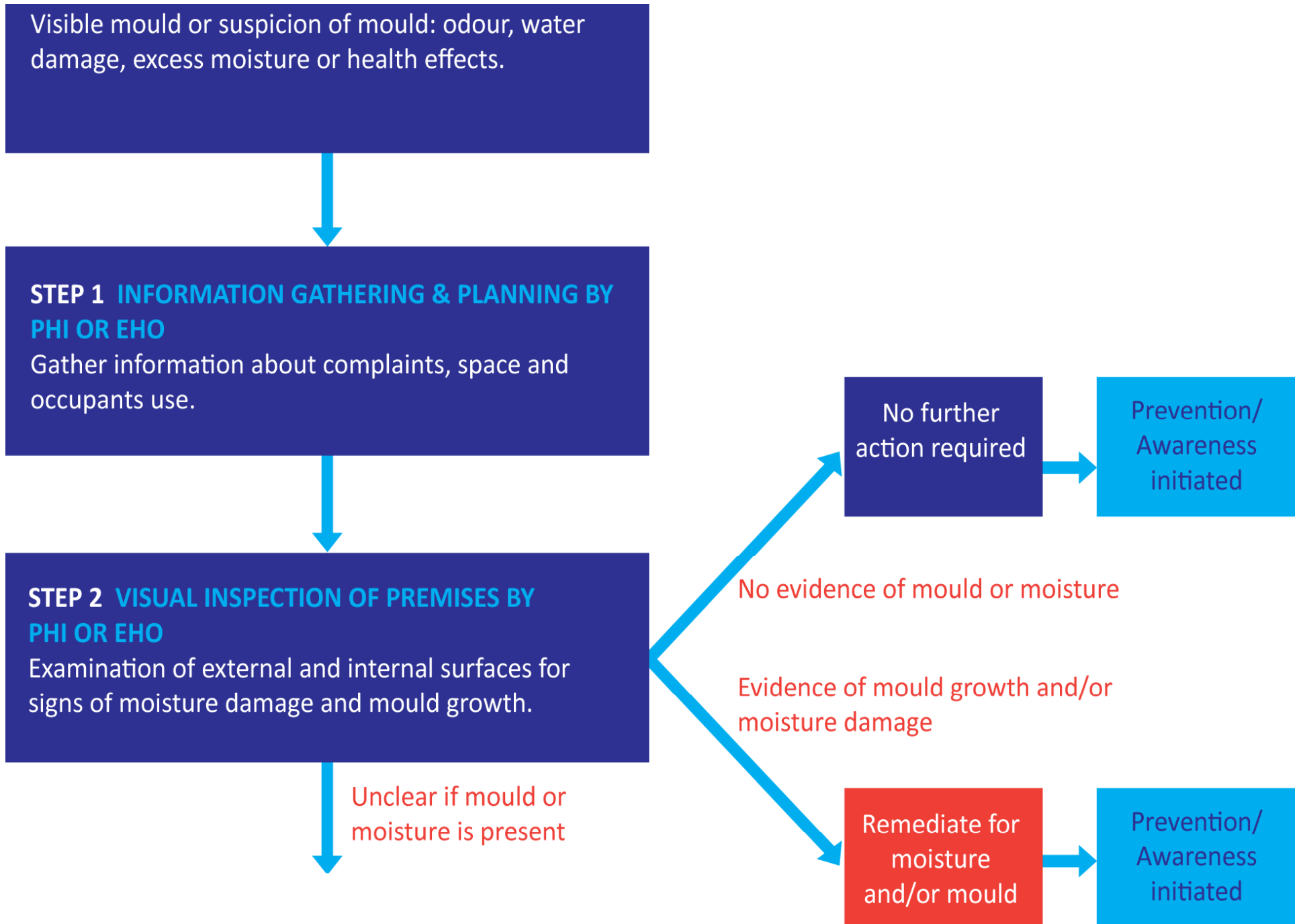
Prevention/Awareness initiated

No evidence of mould or moisture

Evidence of mould growth and/or moisture damage

Remediate for moisture and/or mould

Prevention/Awareness initiated



STEP 3 MOULD SAMPLING BY QUALIFIED ENVIRONMENTAL SPECIALIST/CONSULTANT

Create hypothesis, design and implement sampling protocol with necessary controls.

Do test results provide clear evidence of indoor mould contamination?

NO

No further action required

Prevention/Awareness initiated

YES

STEP 4 IF NECESSARY, ENVIRONMENTAL SPECIALIST/CONSULTANT INVESTIGATES SUSPECT HIDDEN AREAS

Invasive techniques used only if a strong suspicion or evidence exists.

No evidence of mould or moisture

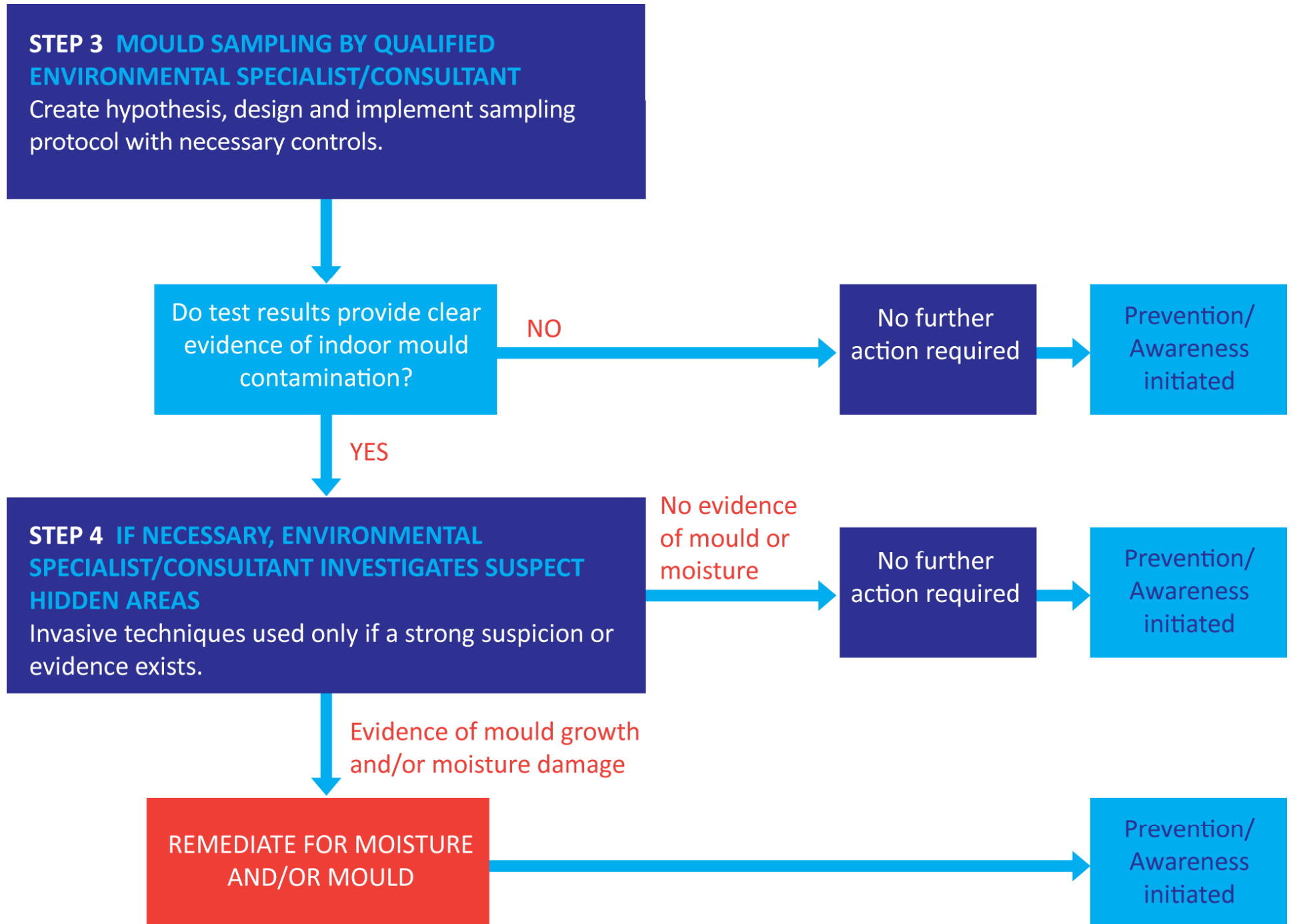
No further action required

Prevention/Awareness initiated

Evidence of mould growth and/or moisture damage

REMEDIATE FOR MOISTURE AND/OR MOULD

Prevention/Awareness initiated





EXPOSURE ASSESSMENT

Exposure Assessment

- Indoor mould not directly related to exposure or health effects
 - Mould not the only possible contributor to a health effect (eg., dampness)
 - Different components of mould can be harmful
 - Exposure determined by more than just the quantity of mould present
 - Exposure can occur anywhere
 - Individual susceptibility is a major factor

Visual Inspection: What to look for

- Indicators of past and present water damage
 - Wet spots (moisture meter), actual mould growth
 - Cracks in materials, staining, efflorescence, decayed or warped wood, wrinkled wall paper, bubbled paint
 - Condensation
 - Previous repairs and renovations

Exterior Inspection

- Building deficiencies
- Drainage, grade of soil, clearance between soil and siding
- Sprinklers, landscaping
- Roof (if possible)
- Missing drainage elements
- Penetrations



Interior Inspection

- All occupiable areas – floor, walls, ceiling
- Areas under windows
- Fireplace, penetrations
- Under sinks, toilets, in and around baths/showers, dishwashers
- Hot water heaters
- Refrigerators
- Attics, basements, crawlspaces, storage spaces

Documentation and Tools

Documentation

- Floor plan of the building/residence
- Detailed description of observations (include direction, size)
- Photos, photos, photos

Tools

- Moisture meter
- Bendable mirror
- Multipurpose tool (knife, pliers)
- T/RH meter
- Clipboard
- Multicoloured pen



Testing



- Surface – tape, culture, bulk (material)
- Dust – vacuum, tape
- Air sampling
 - Total spore (onto a slide for microscopy)
 - Culturable (onto agar for culture and speciation)
 - DNA (polymerase chain reaction)
- Destructive
 - Removal of wallboard, cabinetry, carpeting, baseboards



Limitations of Testing

- Snapshot in time
- Doesn't inform of actual exposure
- Not well-standardized or validated
- Difficult to interpret
 - Most compare indoors with outdoors
 - Johnson et al., 2008 shows that when 30 sets of air sample datasets were sent to 40 IAQ professionals, inconsistent conclusions
 - No prior history or other information provided
- Testing not that useful by itself

What do you do if you have a mould problem?

- Remove source of water
- Remove/replace porous, semiporous materials
- Clean hard surfaces
- Many guidelines
 - NYCDOH, 1993, 2000
 - Health Canada, 1995
 - ACGIH, 1999
 - US EPA, 2001
 - AIHA, 2001



Photo courtesy of Terry Brennan,
<http://www.epa.gov/mold/moldcourse/imagegallery7.html>

Classification	Description	Necessary Precautions
Small /Area 1	Total area: 1 m ² of visible mould growth or less.	<p>Most guidelines recommend that occupants can clean up areas less than 1 m². No special training is required</p> <p>Recommended Personal Protective Equipment (PPE): N-95 mask and rubber gloves</p> <p>Guidelines disagree about whether containment is required for this size of growth^{17,18}</p>
Moderate/ Area II	Total area: between 1–4 m ² of visible mould.	<p>Most guidelines recommend that occupants can clean up moderate areas if they have received some training and are using proper procedures</p> <p>Recommended PPE: N-95 mask, goggles and rubber gloves</p> <p>Minimal containment is required, including air filtration and barriers.</p>
Large/Area III	Total area: 4–10 m ² of visible mould.	<p>Professional remediation only*</p> <p>Full PPE, air filtration and full containment required.</p>
Extensive contamination/ Area IV	Contiguous visible mould growth larger than 10 m ² in an area.	<p>Professional remediation only*</p> <p>Full PPE, air filtration and full containment required.</p> <p>Note: only guidelines from the New York City Department of Health and Mental Hygiene¹⁴ and the US Department of Labour¹⁷ include extensive areas of mould growth.</p>

Limitations

- Limited understanding of “dampness”
- Limited dampness and mould exposure assessment methods
- Lack of knowledge of which mould or components in indoor air are problematic
- Lack of biomarkers for assessing exposure
- Reported health effects not standardized
- No dose-response curve established
- Lack of evidence on extent of containment for remediation
- Lack of tools for assessing success of remediation

Conclusions

- Mould in indoor environments associated with asthma and upper respiratory effects
- Visual inspection and information gathering is the most important step in exposure assessment
- Mould growth in indoor environments should be remediated and moisture source stopped

Thank You

Questions?

Comments?

www.ncceh.ca | www.ccnse.ca

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