

Quantitative, Real-Time Polymerase Chain Reaction Analysis

Environmental Relative Moldiness Index (ERMI)



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Client:	William Turner, CIH	Project: North Hills, NY
Job #:	74-NorthHills Condo	Collected: 10/07/08
Received:	10/08/08	Reported: 10/09/08
ABC ID:	BI101507-6-1	Analyst: L. Rothorn, Ph.D.

US-EPA License # 416-07

Notes

The Environmental Relative Moldiness Index (ERMI) is a Quantitative, Real-Time Polymerase Chain Reaction (QPCR) panel of testing for indoor molds that was developed by the United States Environmental Protection Agency (US-EPA). This panel includes 26 mold species and groups of species that are known to thrive in water-damaged homes. This panel also includes 10 species and groups of species of molds that are found in all homes, with or without water damage. Each species and group of species is enumerated from DNA extracted from dust samples taken from both the living and sleeping quarters of homes. Concentrations of each of the 36 molds are used to derive an "ERMI Score" that rates the "moldiness" of each sample against those tested by the US-EPA. These values range from approximately -10 (low moldiness) to 20 (high moldiness).

Selected References

1. Haugland, R. A. and S. J. Vesper. 2002. Method of identifying and quantifying specific fungi and bacteria. US Patent 6,387,652 B1.
2. Vesper, S. J. 2006. Developing the EPA Relative Moldiness Index® based on mold-specific quantitative PCR. The Synergist April 2006:39-43.
3. Haugland, R. A., S. J. Vesper and L. J. Wymer. 1999. Quantitative measurement of *Stachybotrys chartarum* conidia using real time detection of PCR products with the TaqMan™ fluorogenic probe system. Molecular and Cellular Probes 13:329-340.
4. Meklin, T. M., R. A. Haugland, T. Reponen, M. Varma, Z. Lummus, D. Bernstein, L. J. Wymer and S. J. Vesper. 2004. Quantitative PCR analysis of house dust can reveal abnormal mold conditions. Journal of Environmental Monitoring 6:615-620.
5. Vesper, S. J., C. McKinstry, C. Yang, R. A. Haugland, C. M. Kercksmar, I. Yike, M. D. Schluchter, H. L. Kirchner, J. Sobolewski, T. M. Alltan and D. G. Dearborn. 2006. Specific molds associated with asthma in water-damaged homes. Journal of Occupational and Environmental Medicine 48:852-858.



Guidelines to Follow When Interpreting an ERMI SCORE

(See illustration two for ERMI diagnostic chart)

The Asthma and Allergy Foundation of America has classified the following symptoms for mold allergies:

- Sneezing
- Chronic cough
- Runny nose
- Nasal congestion
- Itchy, watery and red eyes
- Skin rashes and hives
- Sinus headaches
- Reduced lung capacity and difficulty breathing

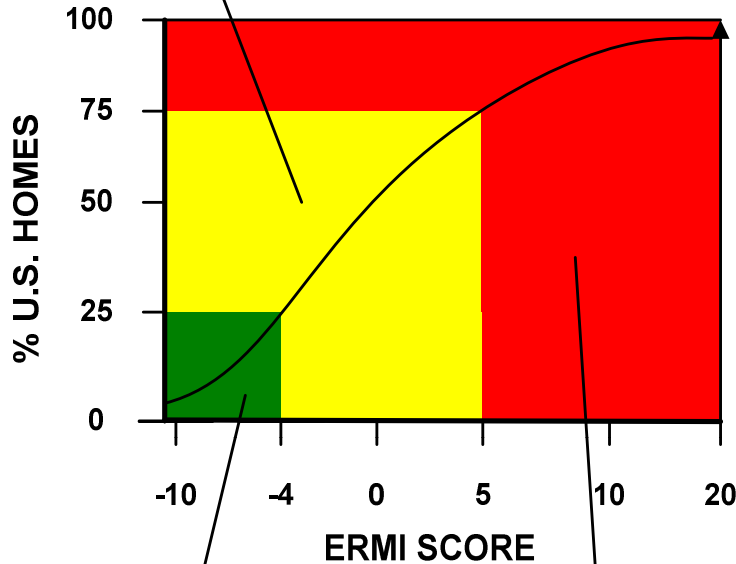
Mold-exposure symptoms differ from person to person, depending upon the sensitivities of each individual and their levels of exposure to mold. Persons that are extremely sensitivity to mold, or those with suppressed immune systems, could be at higher risk for allergic reactions than those that are less sensitive and have full immune system function. Reaction to mold exposure can be immediate or delayed, depending on the individual and their susceptibility and exposure levels.

The US-EPA has developed a 36-species panel of Mold-Specific Quantitative Polymerase Chain Reaction (MSQPCR) analyses called the Environmental Relative Moldiness Index (ERMI). House dust is used as the medium for this test. Quantities of these species in 1 mg of dust are used to derive an "ERMI Score" that rates the moldiness of a home, based upon scores from approximately 1100 homes tested in the US. Clean Air Laboratories recognizes three broad categories of "moldiness" that are of particular importance to occupants of homes. These levels and possible health implications are listed in the table below.

It should be noted that there is no implicit human-health recommendation with an ERMI score. An ERMI score should be used in conjunction with individual mold species quantifications and symptoms of home occupants to arrive at an action decision. An ERMI score is simply a guideline for determining levels of mold exposure for home occupants. A detailed diagnostic chart is on the next page. As research by the US-EPA and Clean Air Labs accumulates, interpretations of ERMI scores could change.

ENVIRONMENTAL RELATIVE MOLDINESS INDEX (ERMI)

ERMI = (-4 to 5) MODERATE
Mold-exposure symptoms will vary with the individual. Some individuals exhibit a greater sensitivity to mold than others.



ERMI = (-10 to -4) LOW
These homes hold the lowest ERMI value. Occupants of these homes are least likely to show symptoms of mold exposure. However, mold-exposure symptoms are not impossible.

ERMI = (5 to 20) High
Occupants of these homes are the most likely to show mold-exposure symptoms. However, mold-exposure symptoms are not certain. Some individuals who are least sensitive to mold may remain asymptomatic even when the ERMI score exceeds 5.

Key to ERMI Assays



Assay name

Target species / group of species

Group 1 Molds

Afumi	<i>Aspergillus fumigatus, Neosartorya fischeri</i>
Aochr1	<i>Aspergillus ochraceus / ostianus</i>
Arest	<i>Aspergillus restrictus / caesillus / conicus</i>
Asclr	<i>Aspergillus sclerotiorum</i>
Aungu	<i>Aspergillus unguis</i>
Avers2-2	<i>Aspergillus versicolor</i>
Apeni2	<i>Aspergillus penicillioides</i>
Cspha	<i>Cladosporium sphaerospermum</i>
Eamst	<i>Eurotium (Aspergillus) amstelodami / chevalieri / herbariorum / rubrum / repens</i>
Ppurp	<i>Penicillium purpurogenum</i>
Stac	<i>Stachybotrys chartarum</i>
Aflav	<i>Aspergillus flavus / oryzae</i>
Anigr	<i>Aspergillus niger / awamori / foetidus / phoenicis</i>
Asydo3	<i>Aspergillus sydowii</i>
Apull	<i>Aureobasidium pullulans</i>
Cglob	<i>Chaetomium globosum</i>
Pvari2	<i>Paecilomyces variotii</i>
Pbrev	<i>Penicillium brevicompactum / stoloniferum</i>
Pcory	<i>Penicillium corylophilum</i>
PenGrp2	<i>Penicillium crustosum / camembertii / commune / echinulatum / solitum</i>
Pspin2	<i>Penicillium glabrum / lividum / purpurescens / spinulosum / thomii</i>
Pvarb2	<i>Penicillium variable</i>
SCbrv	<i>Scopulariopsis brevicaulis / fusca</i>
SCchr	<i>Scopulariopsis chartarum</i>
Tviri	<i>Trichoderma viride / atroviride / koningii</i>
Wsebi	<i>Wallemia sebi</i>

Group 2 Molds

Astrc	<i>Acremonium strictum</i>
Aaltr	<i>Alternaria alternata</i>
Cclad1	<i>Cladosporium cladosporioides</i> svar. 1
Cclad2	<i>Cladosporium cladosporioides</i> svar. 2
Cherb	<i>Cladosporium herbarum</i>
Austs2	<i>Aspergillus ustus</i>
Enigr	<i>Epicoccum nigrum</i>
Muc1	<i>Mucor amphibiorum / circinelloides / hiemalis / indicus / mucedo / racemosus / ramosissimus and Rhizopus azygosporus / homothalicus / microsporus / oligosporus / oryzae</i>
Pchry	<i>Penicillium chrysogenum</i>
Rstol	<i>Rhizopus stolonifer</i>



Sample ID: BI101507-6-1

Description: Den and bedroom

Group 1 Molds	Spores / mg dust	Group 2 Molds	Spores / mg dust
<i>Aspergillus fumigatus</i>	365	<i>Acremonium strictum</i>	2,231
<i>Aspergillus ochraceus</i>	0	<i>Alternaria alternata</i>	635
<i>Aspergillus restrictus</i>	17	<i>Cladosporium cladosporioides svar. 1</i>	311
<i>Aspergillus sclerotiorum</i>	56	<i>Cladosporium cladosporioides svar. 2</i>	4
<i>Aspergillus unguis</i>	0	<i>Cladosporium herbarum</i>	54
<i>Aspergillus versicolor</i>	359	<i>Aspergillus ustus</i>	0
<i>Aspergillus penicillioides</i>	3,066	<i>Epicoccum nigrum</i>	81
<i>Cladosporium sphaerospermum</i>	20	<i>Mucor amphibiorum</i>	3
<i>Eurotium amstelodami</i>	101	<i>Penicillium chrysogenum</i>	4
<i>Penicillium purpurogenum</i>	11	<i>Rhizopus stolonifer</i>	8
<i>Stachybotrys chartarum</i>	1		
<i>Aspergillus flavus</i>	0		
<i>Aspergillus niger</i>	3		
<i>Aspergillus sydowii</i>	1		
<i>Aureobasidium pullulans</i>	1,057		
<i>Chaetomium globosum</i>	3		
<i>Paecilomyces variotii</i>	5		
<i>Penicillium brevicompactum</i>	0		
<i>Penicillium corylophilum</i>	0	Sum of Logs Group 1:	25.2
<i>Penicillium crustosum</i>	0	Sum of Logs Group 2:	14.9
<i>Penicillium glabrum</i>	67		
<i>Penicillium variable</i>	15		
<i>Scopulariopsis brevicaulis</i>	0		
<i>Scopulariopsis chartarum</i>	1		
<i>Trichoderma viride</i>	5		
<i>Wallemia sebi</i>	10		

ERMI Score: 10.3