Quantitative, Real-Time Polymerase Chain Reaction Analysis

Environmental Relative Moldiness Index (ERMI)

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Inspector:	Certified Industrial Hygienist	**Collected:** 01/01/10	
Project:	Moldy Home	**Received:** 01/02/10	
Job #:	CI012453	**Reported:** 01/03/10	
Assured Bio ID:	CIH010110-1	**Analyst:** M. McGraw & J. Wu	

Assured Bio Labs, LLC. operates under ISO 17025:2005 and a US-EPA license for MSQPCR (# 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 TaqManTM 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. Kercsmar, 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.

Disclaimer

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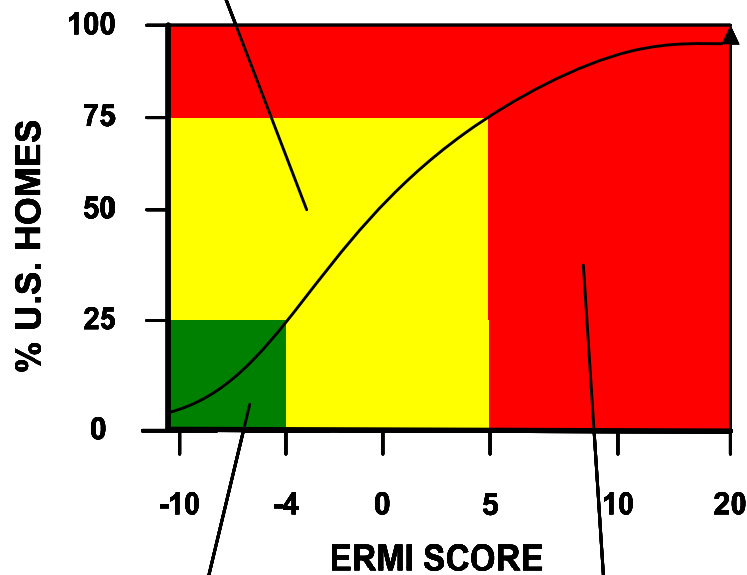
It should be noted that there is no implicit human-health recommendation with an ERMI score. An ERMI score should be used in conjunction with individual mold species quantifications and symptoms of home occupants to arrive at an action decision. An ERMI score is simply a guideline for determining levels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

We have included the sums of the logs of Group 1 and 2 mold species. These are used for calculating the ERMI score. However, the sum of the logs of Group 2 molds can also be used as a general indicator. This value should be between 7-14 for a home in which mold species have come into equilibrium with outdoor species. Values lower than this usually indicate that the home is new and has not yet equilibrated to the outdoor environment. Values are also commonly low after a remediation event. Values that are high could indicate that cleaning regimes are insufficient, or that a water intrusion event was large enough to cause Group 2 molds to grow in number along with Group 1 molds.

ENVIRONMENTAL RELATIVE MOLDINESS INDEX (ERMI)

Chart axes: % U.S. HOMES (0, 25, 50, 75, 100) vs ERMI SCORE (-10, -4, 0, 5, 10, 20)

Key to ERMI Assays

Assay name	Target species / group of species
Group 1 Molds	
Afumi	*Aspergillus fumigatus, Neosartorya fischeri*
Aochr1	*Aspergillus ochraceus / ostianus*
Arest	*Aspergillus restrictus / caesillus / conicus*
Asclr	*Aspergillus sclerotiorum*
Aungu	*Aspergillus unguis*
Avers2-2	*Aspergillus versicolor*
Apeni2	*Aspergillus penicillioides*
Cspha	*Cladosporium sphaerospermum*
Eamst	*Eurotium (Aspergillus) amstelodami / chevalieri / herbariorum / rubrum / repens*
Ppurp	*Penicillium purpurogenum*
Stac	*Stachybotrys chartarum*
Aflav	*Aspergillus flavus / oryzae*
Anigr	*Aspergillus niger / awamori / foetidus / phoenicis*
Asydo3	*Aspergillus sydowii*
Apull	*Aureobasidium pullulans*
Cglob	*Chaetomium globosum*
Pvari2	*Paecilomyces variotii*
Pbrev	*Penicillium brevicompactum / stoloniferum*
Pcory	*Penicillium corylophilum*
PenGrp2	*Penicillium crustosum / camembertii / commune / echinulatum / solitum*
Pspin2	*Penicillium glabrum / lividum / purpurescens / spinulosum / thomii*
Pvarb2	*Penicillium* variable
SCbrv	*Scopulariopsis brevicaulis / fusca*
SCchr	*Scopulariopsis chartarum*
Tviri	*Trichoderma viride / atroviride / koningii*
Wsebi	*Wallemia sebi*
Group 2 Molds	
Astrc	*Acremonium strictum*
Aaltr	*Alternaria alternata*
Cclad1	*Cladosporium cladosporioides* svar. 1
Cclad2	*Cladosporium cladosporioides* svar. 2
Cherb	*Cladosporium herbarum*
Austs2	*Aspergillus ustus*
Enigr	*Epicoccum nigrum*
Muc1	*Mucor amphibiorum / circinelloides / hiemalis / indicus / mucedo / racemosus / ramosissimus and Rhizopus azygosporus / homothalicus / microsporus / oligosporus / oryzae*
Pchry	*Penicillium chrysogenum*
Rstol	*Rhizopus stolonifer*

Sample ID: CIH010110-1-1

Description: Master Bedroom and Living Room

Group 1 Mold Species	Assay Name	Spores/mg dust	Group 2 Mold Species	Assay Name	Spores/mg dust
Aspergillus fumigatus	Afumi	7	*Acremonium strictum*	Astrc	ND
Aspergillus ochraceus	Aochr1	ND	*Alternaria alternata*	Aaltr	197
Aspergillus restrictus	Arest	ND	*Cladosporium cladosporioides svar. 1*	Cclad1	ND
Aspergillus sclerotiorum	Asclr	370	*Cladosporium cladosporioides svar. 2*	Cclad2	ND
Aspergillus unguis	Aungu	ND	*Cladosporium herbarum*	Cherb	444
Aspergillus versicolor	Avers2-2	ND	*Aspergillus ustus*	Austs2	ND
Aspergillus penicillioides	Apeni2	ND	*Epicoccum nigrum*	Enigr	ND
Cladosporium sphaerospermum	Cspha	42	*Mucor amphibiorum*	Muc1	1
Eurotium amstelodami	Eamst	ND	*Penicillium chrysogenum*	Pchry	ND
Penicillium purpurogenum	Ppurp	ND	*Rhizopus stolonifer*	Rstol	ND
Stachybotrys chartarum	Stac	567			
Aspergillus flavus	Aflav	ND			
Aspergillus niger	Anigr	ND			
Aspergillus sydowii	Asydo3	2,696			
Aureobasidium pullulans	Apull	ND			
Chaetomium globosum	Cglob	ND			
Paecilomyces variotii	Pvari2	1			
Penicillium brevicompactum	Pbrev	ND			
Penicillium corylophilum	Pcory	ND			
Penicillium crustosum	PenGrp2	4,392			
Penicillium glabrum	Pspin2	ND			
Penicillium variable	Pvarb2	ND			
Scopulariopsis brevicaulis	SCbrv	1,654			
Scopulariopsis chartarum	SCchr	ND	**Sum of logs of Group 1 species:**		18.3
Trichoderma viride	Tviri	ND	**Sum of logs of Group 2 species:**		4.9
Wallemia sebi	Wsebi	2			

ERMI Score: 13.4