

**MOLD EXPOSURES & POPULATION HEALTH**

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**10 year Average Annual Burden of Fungal Spores  
in Outdoor Air at 20m the Northern Hemisphere**

<i>Cladosporium cladosporioides &amp; C.herbarum</i>	55%
Ascospores	19%
Basidiospores	12%
<i>Sporobolomyces</i>	10%
<i>Alternaria alternata</i>	2%
<i>Ustilago, Erysiphe, Helminthosporium,</i>	
<i>Botrytis, Tilletiopsis, Stemphylium, Epicoccum</i>	2%
<i>Aspergillus/Penicillium</i>	1%

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**There are Population Health Effects  
of Molds in Outdoor Air**

ca. 10% of Americans are allergic to *Cladosporium*

ca. 8% of emergency admissions to hospitals for  
asthma are associated with spores

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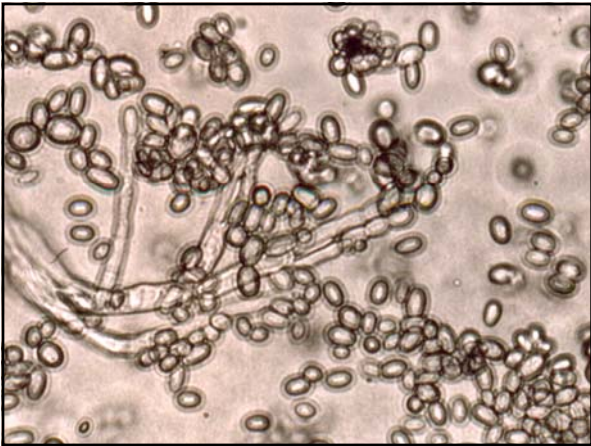
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### Fungi from 2134 Wallboard Samples

- Chaetomium globosum*
- Penicillium viridicatum*
- Non sporulating isolates
- Eurotium herbariorum*
- Penicillium aurantiogriseum*
- Penicillium citrinum*
- Stachybotrys chartarum*, *S. chlorohalonata*
- Aspergillus sydowii*
- Penicillium chrysogenum*
- Penicillium commune*
- Non sporulating, clamp connections
- Eurotium repens*
- Memnoniella echinata*
- Aspergillus versicolor*
- Paecilomyces variotii*
- Cladosporium sphaerospermum*

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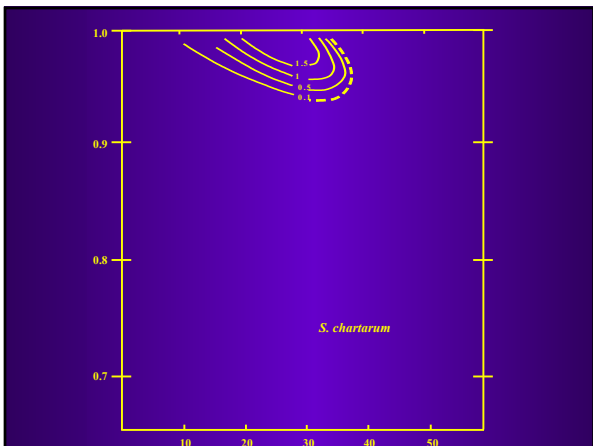
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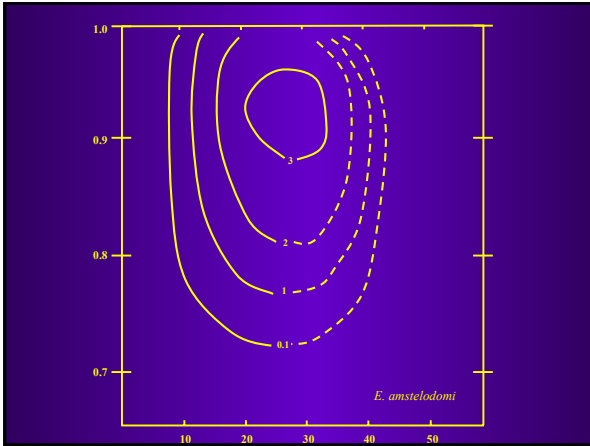
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## SECONDARY METABOLISM

- Growth unrestrained by nutrients, pH, water and gas exchange is called “balanced growth”.
- In fungi, secondary metabolites are produced when one or more of nutrients become limiting; called unbalanced growth.
- This produces pools of precursors that become available for the production of secondary metabolites.

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## SECONDARY METABOLISM

- responsible for the biosynthesis of usually complex compounds for defense
- astounding range of compounds but all are synthesized from amino acids, acetate, mevalonic acid or glutamic acid

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## SECONDARY METABOLISM

- Serious research started in the late 1930's when the need for penicillin became acute.
- Early researchers believed that these compounds had a purpose in nature. After WWII, some scientists thought that secondary metabolites were waste products or their production was a displacement activity (!).

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## SECONDARY METABOLISM

- In plants, secondary metabolites are usually tissue-specific. Needles, leaves, seeds, where the plants have male and female forms, the female forms can have more metabolite.
- Some fungi have tissue specific secondary metabolites (spores, sclerotia).

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Species/ chemotype	Atranones	Dolabellaues	Tricho- dermin	Satratoxins	Roridin	Hydroxy roridin E	Pigmen- tation
<i>chartarum</i> /S	ND*	ND	+	+	+	+	None
<i>chartarum</i> /S	ND	ND	+	+	+	+	None
<i>chartarum</i> /S	ND	ND	+	+	+	+	Yellow
<i>chartarum</i> /S	ND	ND	+	+	+	+	Yellow
<i>chartarum</i> /S	ND	ND	+	+	+	+	Yellow
<i>chartarum</i> /S	ND	ND	+	+	+	+	None
<i>chartarum</i> /S	ND	ND	ND	+	+	+	None
<i>chartarum</i> /S	ND	ND	ND	+	+	+	None
<i>chartarum</i> /A	+	+	+	ND	ND	ND	None
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<i>chartarum</i> /A	+	+	+	ND	ND	ND	None
<i>chartarum</i> /A	+	+	+	ND	ND	ND	None
<i>chlormalonata</i>	+	+	+	ND	ND	ND	Green
<i>chlormalonata</i>	+	+	+	ND	ND	ND	Green
<i>chlormalonata</i>	+	+	+	ND	ND	ND	Green
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<i>chlormalonata</i>	+	+	+	ND	ND	ND	Green
<i>chlormalonata</i>	+	+	+	ND	ND	ND	Green
<i>chlormalonata</i>	ND	ND	ND	ND	ND	ND	Green

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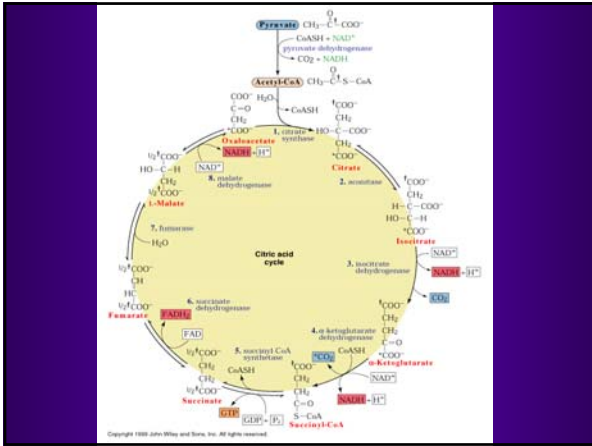
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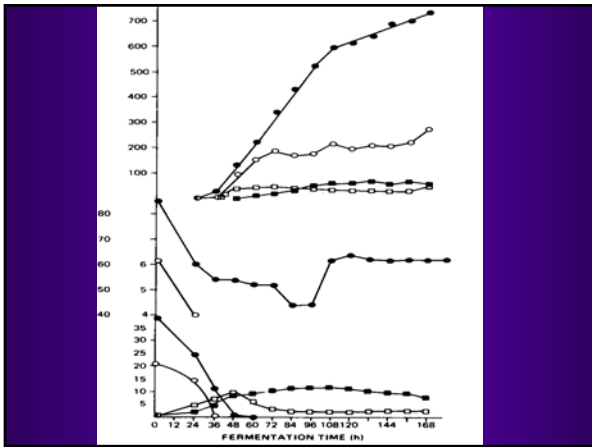
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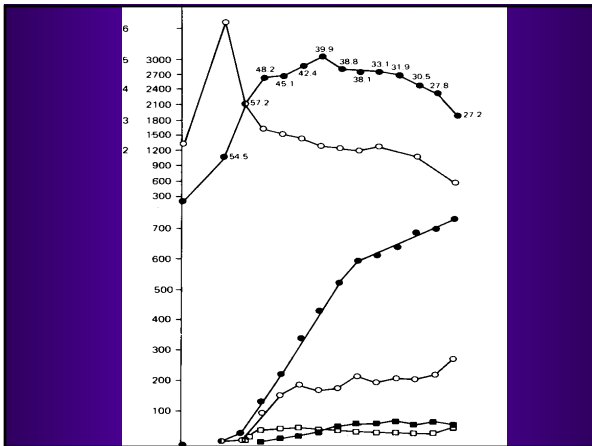
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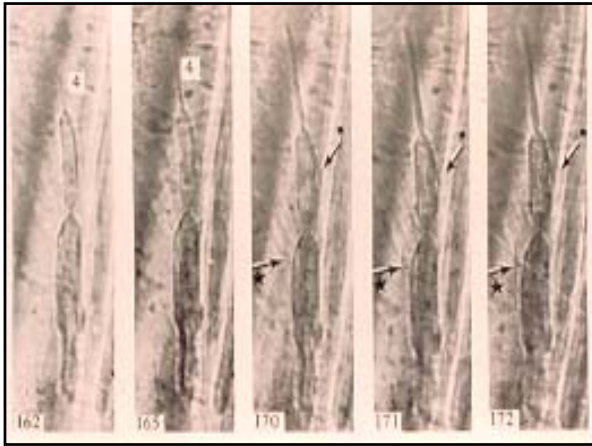
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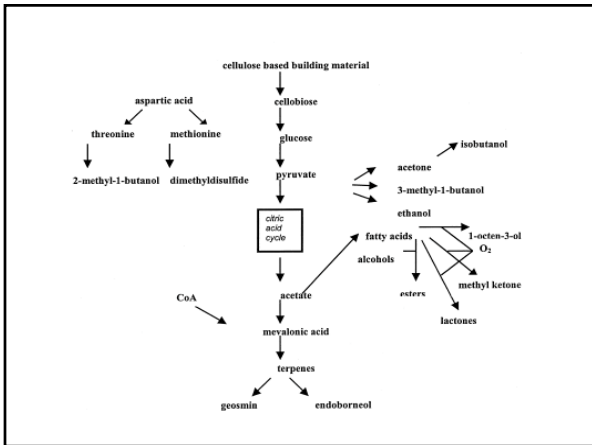
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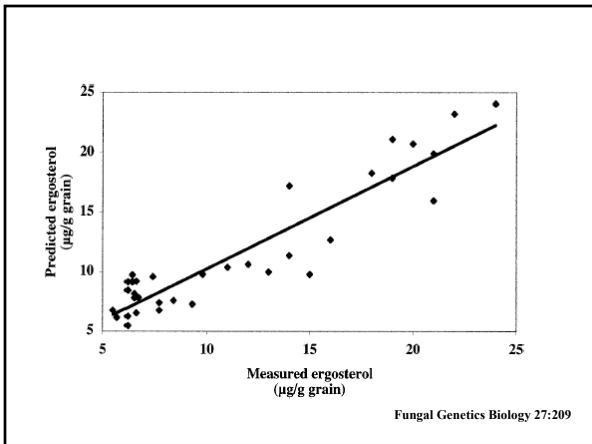
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## SPORE GLUCAN CONTENT

Species	DG18	MEA	CMA	CZ
<i>E. herbariorum</i>	0.137 ± 0.001**	0.118 ± 0.006	0.115 ± 0.004	0.105 ± 0.005
<i>P. aurantiogriseum</i>	0.204 ± 0.002**	0.170 ± 0.004	0.168 ± 0.007	0.174 ± 0.005
<i>S. chartarum</i>		0.736 ± 0.012	0.714 ± 0.02	0.738 ± 0.01

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## SECONDARY METABOLITES ALWAYS PRODUCED

- if fungus grows in nature
- *a priori* species must be competitive on substrate
- need to measure the toxin for the right chemotype
- detection biomass dependent
- adequate sensitivity

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## Mold measures: ruler still the best

- **British Bengali (1990), Wallaceburg (1998) and Finnish studies (2002) showed that respiratory symptoms were associated with area of fungal contamination/moisture damage.**
- **Population health effects could be DETECTED at circa 1-3% visible mold per unit floor area.**

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all media are selective: pure cultures

	<u>MEA</u>	<u>CMA</u>	<u>DG18</u>	<u>spores</u>
<i>S. chartarum</i>	1	10	1	1,000
<i>P. aurantiogriseum</i>	20	20	25	40
<i>W. sebi</i>	1	1	10	20
<i>T. harzianum</i>	10	10	1	40

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approximate half life (years)\_\_\_\_\_

<i>Cladosporium cladosporioides</i>	0.1
<i>Alternaria alternata</i>	0.3
<i>Fomes annosus</i>	0.3
<i>Stachybotrys chartarum</i>	0.8
<i>Aureobasidium pullulans</i>	1
<i>Fusarium</i> sp.	>4
<i>Mucor</i> sp.	5
<i>Neosartorya fischeri</i>	>5
<i>Talaromyces luteus</i>	>6
<i>P. camemberti</i>	>6
<i>Scorulopsis brevicaulis</i>	>6
<i>Emercella nidulans</i>	>6
<i>A. niger</i>	>6
<i>A. fumigatus</i>	>7
<i>Eurotium herbariorum</i>	>7
<i>Rhizopus nigraus</i>	11
<i>Aspergillus flavus</i>	>11
<i>A. oryzae</i>	>11

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Settled dust per m<sup>2</sup> in houses can be large:

	<u>&gt;300 <math>\mu</math>m</u> (mg)	<u>&lt;300 to &gt;150 <math>\mu</math>m</u> (mg)	<u>&lt; 150 <math>\mu</math>m</u> (mg)
LR	865	315	678
PBR	391	134	298
CBR	122	32	241
LR	104	64	321
PBR	274	511	477
CBR	596	675	691
LR	167	84	257
PBR	178	536	164
CBR	184	1600	1308

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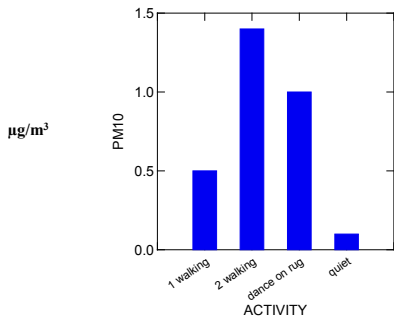
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Mass of settled dust and room activity are the variables dominating exposure and the results of air samples of any kind.



Health effects related to mass of settled dust/m<sup>2</sup> in several studies

Environ Sci Technol 38:1759

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## Ergosterol & duration of samples

houses	% positive	mean	median	
		ng/m <sup>3</sup>		
401	25	0.5	(+s)	1 day
110	98	0.3	0.15	5 days

proxy for room activity and dust burden

AIHJ 58:39; Foto et al. 2004

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The majority of exposure to particles indoors comes from settled dusts; personal exposure time/activity dependent.

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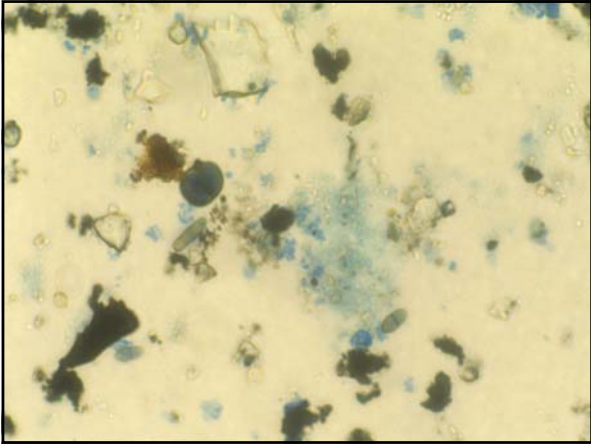
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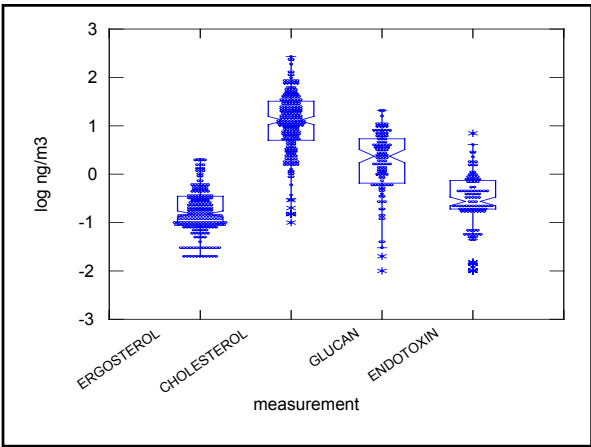
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The exposure to particles indoors is much more than just fungal materials.

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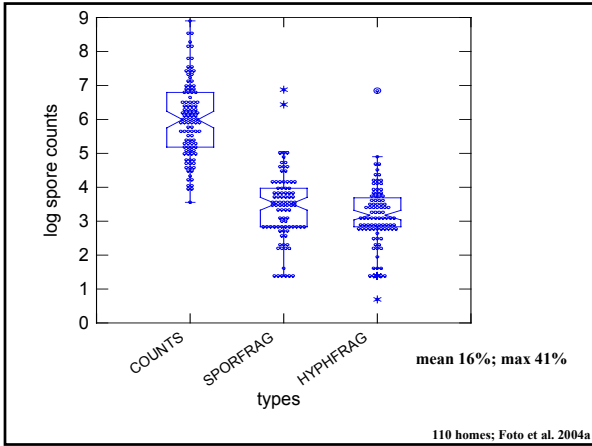
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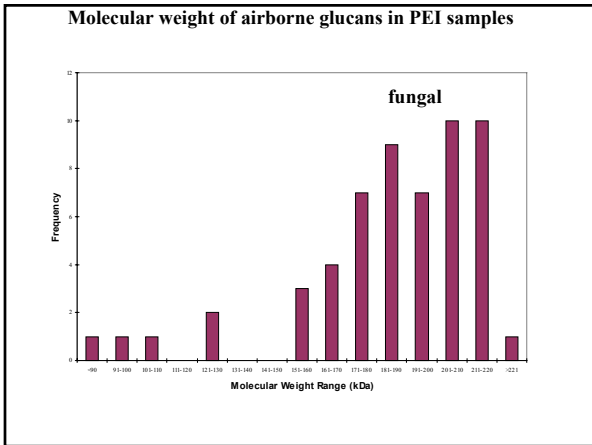
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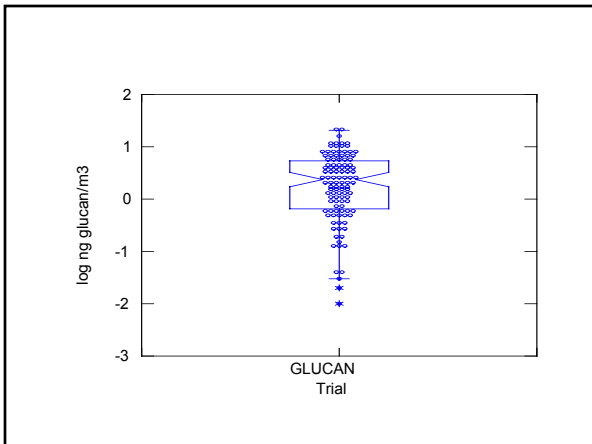
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## Fungal materials as % of glucan

- 30% intact spores
- 30% hyphal and spore fragments
- 40% something else much smaller
  - small amount is yeast glucan

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The fungal component of the exposure is more than to intact spores.

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