

Pharos in the Classroom – Designing safer spaces and products

Rena Miu - Healthy Building Network
Hanno Erythropel, PhD - Yale University
Bobby Ilg, M. Arch - Algonquin College



Agenda

1. Pharos introduction
2. Pharos in the Fundamentals of Green Chemistry & Green Engineering course
3. Using Pharos to investigate building material ingredients and chemical sensitivities
4. Q+A



MISSION

To advance human and environmental health by improving hazardous chemical transparency and inspiring product innovation



About Pharos

146K

Chemicals,
polymers,
metals &
other
substances

20K

Chemicals with
functional use
data

800

Compound
Groups

300

Full Green
Screen Hazard
Assessments

GreenScreen[®] for Safer Chemicals

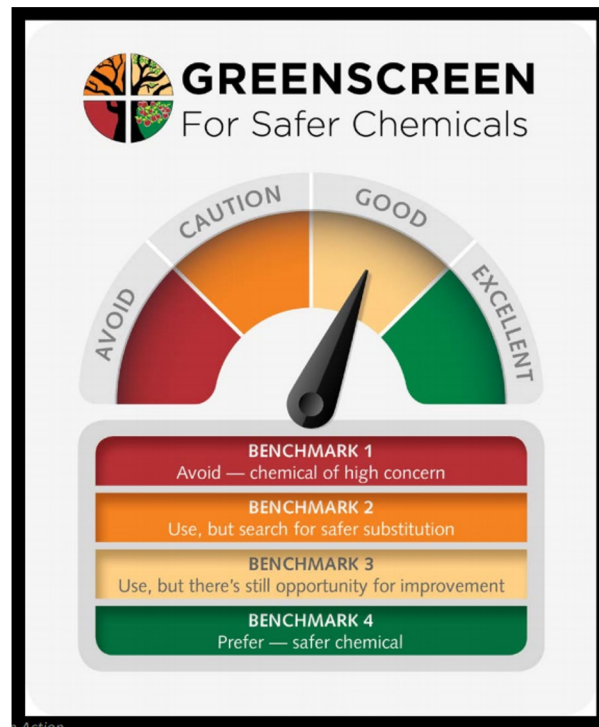
A comparative chemical hazard assessment method.

Provides a simple rating system to help decision makers compare chemicals.

Developed by the nonprofit organization Clean Production Action.

GreenScreen List Translator

LT-1	Likely
Benchmark 1	
LT-P1	Possible
Benchmark 1	
LT-UNK	Benchmark Unknown



Save Time Finding Hazard Information



- Screen chemicals for hazards
- Utilize the power of compound groups

Screen Chemicals for Hazards

8001-54-5

Benzalkonium chloride

ALSO CALLED [8045-21-4] ALKYL DIMETHYLBENZYLAMMONIUM CHLORIDE (primary CASRN is 8001-54-5), [12741-06-9] Benzalk...

View all synonyms (10)

Share Profile



Hazards

Properties

Functional Uses

Process Chemistry

Resources

All Hazards View ▾

Show PubMed Results

Request Assessment

Add to Comparison ▾

	GS Score	Group I Human					Group II and II* Human								Ecotox			Fate		Physical		Mult	Non-GSLT					
		C	M	R	D	E	AT	ST	ST	N	N	SnS	SnR	IrS	IrE	AA	CA	ATB	P	B	Rx	F	Mult	PBT	GW	O	Other	
All Hazards	LT-P1	-	-	-	-	-	vH	-	-	-	-	H	H-M	vH	vH	vH	-	M	-	-	-	-	H	-	-	-	-	R

Hazard Lists

Download Lists

ENDPOINT	HAZARD LEVEL	GS SCORE	LIST NAME	HAZARD DESCRIPTION	OTHER LISTS
Acute Mammalian Toxicity	vH	LT-UNK	GHS - Japan	Acute toxicity (inhalation: dust, mist) - Category 2 [H330]	+12

Screen Chemicals for Hazards

8001-54-5

Benzalkonium chloride

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Hazards

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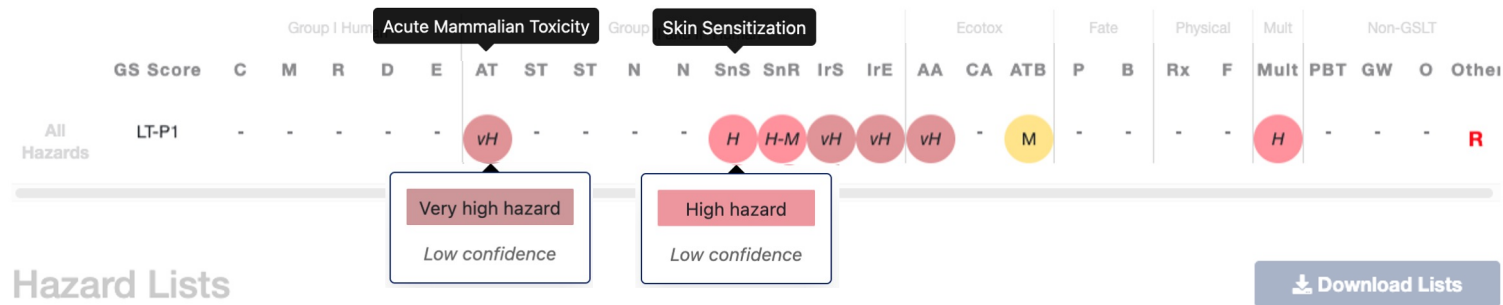
Resources

All Hazards View

Show PubMed Results

Request Assessment

Add to Comparison



Hazard Lists

ENDPOINT	HAZARD LEVEL	GS SCORE	LIST NAME	HAZARD DESCRIPTION	OTHER LISTS
Acute Mammalian Toxicity	vH	LT-	GHS - Japan	Acute toxicity (inhalation: dust, mist) -	

Identify chemicals of interest

Q electronic solvents

Search

Chemicals (0) Common Products (0) Functional Uses (22) Other Resources (0)

Add to Comparison ▾

FAQ ⓘ

<input type="checkbox"/>	CHEMICAL	FUNCTION	PRODUCT TYPE	PRODUCT NAME	SOURCE
<input type="checkbox"/>	Carbon disulfide 75-15-0	mfr of rayon, carbon tetrachloride, xanthogenates, soil disinfectants, electronic vacuum tubes. solvent for phosphorus, sulfur, selenium, bromine, iodine, fats, resins, rubbers			ⓘ
<input type="checkbox"/>	PERFLUORO COMPOUNDS, C5-18 86508-42-1	these specialty chemicals are used primarily in the industrial electronics industry the principal applications include industrial heat transfer in semiconductor processing, electronics testing and solvents for computer disc drive lubrication			ⓘ
<input type="checkbox"/>	TRICHLOROTRIFLUOROETHANE (CFC-113 ISOMER) 354-58-5	used as a solvent for cleaning electronic equipment and degreasing of machinery. /former use/			ⓘ

Compare chemicals

Chemical	GS	Group I Human					Group II and II* Human								Ecotox			Fate		Physical		Mult	Non-GSLT					
		C	M	R	D	E	AT	ST	ST	N	N	SnS	SnR	IrS	IrE	AA	CA	ATB	P	B	Rx	F	Mult	PBT	GW	O	Other	
PERFLUORO COMPOUNDS, C5-18 86508-42-1	BM-1	M	DG	DG	DG	DG	L	L	L	DG	DG	DG	DG	L	L	L	L	-	vH	vH	L	L	-	-	-	-	R	
Methyl alcohol 67-56-1	BM-1	L	L	L	H	DG	H	L	L	vH	L	L	L	L	M	L	L	-	vL	vL	L	H	-	-	-	-	R	
Isopropyl alcohol 67-63-0	BM-2	L	L	M	M	DG	L	vH	L	M	L	M	DG	M	H	L	L	-	vL	vL	H	H	-	-	-	-	R	
ACETONE 67-64-1	LT-P1	H-L	-	M	H-M	H-M	pC	pC	-	M-L	vH-M	-	-	-	H	-	-	-	vH-H	-	-	H	H	-	-	-	-	R
Methylchloroform 71-55-6	LT-1	H	-	M	M-L	-	M	-	pC	-	vH-M	pC	-	H	H	vH	-	-	vH-H	-	pC	pC	vH	-	M	vH	R	
BUTYL ACETATE 123-86-4	LT-UNK	-	-	-	M-L	-	M	pC	-	M-L	-	-	-	-	H	M	-	-	vH-H	-	-	M	M	-	-	-	-	R
Methylene chloride 75-09-2	LT-1	H	pC	M	H-M	H-M	M	pC	pC	M-L	vH-M	-	-	H	H	M	-	-	vH-H	pC	-	-	vH	-	pC	-	R	
1,1,2-Trichloro-1,2,2-trifluoroethane 76-13-1	LT-P1	-	-	-	H-L	-	-	-	-	-	-	-	-	-	M	H	-	-	vH-H	-	-	-	vH	-	H	vH	R	
Stoddard solvent 8052-41-3	LT-1	H	H	-	-	-	H	pC	H	pC	vH-L	-	-	H	pC	vH	-	-	-	vH	-	M	H	-	-	-	-	R
Carbon disulfide 75-15-0	BM-1	M	L	H	H	H	vH	vH	H	M	H	L	DG	H	H	H	H	-	vH	vL	L	vH	-	-	-	-	R	
TRICHLOROTRIFLUOROETHANE (CFC-113 ISOMER) 354-58-5	LT-UNK	-	-	-	-	-	-	-	-	-	-	-	-	-	-	pC	-	-	vH-H	-	-	-	U	-	-	vH	R	
1,1,2,2-TETRACHLORO-1,2-DIFLUOROETHANE (CFC-112) 76-12-0	LT-UNK	-	-	-	H-L	-	M	-	-	-	-	-	-	H	M	pC	-	-	-	-	-	-	H	-	-	vH	R	
1,2-Propylene oxide 75-56-9	BM-1	H	H	H	M	M	M	M	M	M	M	M	DG	H	H	M	DG	-	vH	vL	M	vH	-	-	-	-	R	
2-Amino-2-methylpropanol 124-68-5	LT-UNK	-	-	-	M-L	-	-	-	-	-	-	-	-	H	H	M	-	-	-	-	M	H	-	-	-	-	R	
Propylene carbonate 108-32-7	LT-UNK	-	-	-	M-L	-	-	-	-	-	-	-	-	-	H	-	-	-	-	-	-	-	U	-	-	-	R	

Sort by different characteristics

GreenScreen Score

Developmental toxicity

Eye irritation

Flammability

Chemical

PERFLUORO COMPOUNDS, C5-18
86508-42-1
Methyl alcohol
67-56-1
Carbon disulfide
75-15-0
1,2-Propylene oxide
75-56-9
Methylchloroform
71-55-6
Methylene chloride
75-09-2
Stoddard solvent
8052-41-3
ACETONE
67-64-1
1,1,2-Trichloro-1,2,2-trifluoroethane
76-13-1
BUTYL ACETATE
123-86-4
TRICHLOROTRIFLUOROETHANE (CFC-113 ISOMER)
354-58-5
1,1,2,2-TETRACHLORO-1,2-DIFLUOROETHANE (CFC-112)
76-12-0
Isopropyl alcohol
67-63-0

Chemical	GS	Group I Human					Group II and II* Human										Ecotox			Fate		Physico		Mult		Non-GSLT			
		C	M	R	D	E	AT	ST	ST	N	N	SnS	SnR	IrS	IrE	AA	CA	ATB	P	B	Rx	F	Mult	PBT	GW	O	Other		
PERFLUORO COMPOUNDS, C5-18 86508-42-1	BM-1	M	DG	DG	DG	DG	L	L	L	DG	DG	DG	DG	L	L	L	L	-	vH	vH	L	L	-	-	-	-	R		
Methyl alcohol 67-56-1	BM-1	L	L	L	H	DG	H	L	L	vH	L	L	L	L	M	L	L	-	vL	vL	L	H	-	-	-	-	R		
Carbon disulfide 75-15-0	BM-1	M	L	H	H	H	vH	vH	H	M	H	L	DG	H	H	H	H	-	vH	vL	L	vH	-	-	-	-	R		
1,2-Propylene oxide 75-56-9	BM-1	H	H	H	M	M	M	M	M	M	M	M	DG	H	H	M	DG	-	vH	vL	M	vH	-	-	-	-	R		
Methylchloroform 71-55-6	LT-1	H	-	M	M-L	-	M	-	pC	-	vH-M	pC	-	H	H	vH	-	vH-H	-	pC	pC	vH	-	M	vH	R			
Methylene chloride 75-09-2	LT-1	H	pC	M	H-M	H-M	M	pC	pC	M-L	vH-M	-	-	H	H	M	-	vH-H	pC	-	-	vH	-	pC	-	R			
Stoddard solvent 8052-41-3	LT-1	H	H	-	-	-	H	pC	H	pC	vH-L	-	-	H	pC	vH	-	-	vH	-	M	H	-	-	-	-	R		
ACETONE 67-64-1	LT-P1	H-L	-	M	H-M	H-M	pC	pC	-	M-L	vH-M	-	-	H	-	-	-	vH-H	-	-	H	H	-	-	-	-	R		
1,1,2-Trichloro-1,2,2-trifluoroethane 76-13-1	LT-P1	-	-	-	H-L	-	-	-	-	-	-	-	-	M	H	-	-	vH-H	-	-	-	vH	-	H	vH	R			
BUTYL ACETATE 123-86-4	LT-UNK	-	-	-	M-L	-	M	pC	-	M-L	-	-	-	H	M	-	-	vH-H	-	-	M	M	-	-	-	-	R		
TRICHLOROTRIFLUOROETHANE (CFC-113 ISOMER) 354-58-5	LT-UNK	-	-	-	-	-	-	-	-	-	-	-	-	-	pC	-	-	vH-H	-	-	-	U	-	-	-	vH	R		
1,1,2,2-TETRACHLORO-1,2-DIFLUOROETHANE (CFC-112) 76-12-0	LT-UNK	-	-	-	H-L	-	M	-	-	-	-	-	-	H	M	pC	-	-	-	-	-	H	-	-	-	vH	R		
Isopropyl alcohol 67-63-0	BM-2	L	L	M	M	DG	L	vH	L	M	L	M	DG	M	H	L	L	-	vL	vL	H	H	-	-	-	-	R		

Access PubMed results

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Benzalkonium chloride

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View all synonyms (93)

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Hazards Properties Functional Uses Process Chemistry Resources

All Hazards View ▾

Show PubMed Results

Request Assessment

Add to Comparison ▾

GS Score	Group I Human					Group II and II* Human								Ecotox			Fate		Physical		Mult	Non-GSLT				
	C	M	R	D	E	AT	ST	ST	N	N	SnS	SnR	IrS	IrE	AA	CA	ATB	P	B	Rx	F	Mult	PBT	GW	O	Other
All Hazards ⓘ	LT-P1	-	-	-	-	vH	-	-	-	-	H	H-M	vH	vH	vH	-	H	-	-	-	-	vH	-	-	-	R

Hazard Lists ⓘ

Download Lists

ENDPOINT	HAZARD LEVEL	GS SCORE	LIST NAME	HAZARD DESCRIPTION	OTHER LISTS
Acute Mammalian Toxicity	vH	LT-UNK	GHS - Japan	H330 - Fatal if inhaled [Acute toxicity (inhalation: dust, mist) - Category 2]	+11

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[View all synonyms \(93\)](#)

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All Hazards View ▼

Show PubMed Results

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[Add to Comparison](#) ▼

All Hazards i	GS Score	Group I Human					Group II and II* Human								Ecotox			Fate		Physical		Mult	Non-GSLT				
		C	M	R	D	E	AT	ST	ST	N	N	SnS	SnR	IrS	IrE	AA	CA	ATB	P	B	Rx	F	Mult	PBT	GW	O	Other
LT-P1	-	-	-	-	-	vH	-	-	-	-	H	H-M	vH	vH	vH	-	H	-	-	-	-	vH	-	-	-	-	R
PubMed Results	>2K	430	33	97	23	91	86	86	38	38	19	72	62	25	70	2	-	67	3	0	0	-	0	3	0	-	

Hazard Lists i

[Download Lists](#)

ENDPOINT	HAZARD LEVEL	GS SCORE	LIST NAME	HAZARD DESCRIPTION	OTHER LISTS
Acute Mammalian Toxicity	vH	LT-UNK	GHS - Japan	H330 - Fatal if inhaled [Acute toxicity (inhalation: dust, mist) - Category 2]	+11

Request a full chemical hazard assessment



Access a Community of Experts

Pharos

Comparisons Common Products Discussions Account

All Discussions	162
Announcements	42
Community Discussion	25
Feature Requests / Ideas	34
Chemical Discussions	50
Building Materials	11
Unread Posts	

SEARCH DISCUSSIONS

- [80-05-7] BISPHENOL A (BPA)
- [25495-98-1]
- HEXABROMOCYCLODECANE (HBCD)
- PHthalATES (orthophthalates)
- [1314-13-2] ZINC OXIDE

All Discussions + New Discussion

Least toxic vapor barriers Building Materials

Ramune Bartuskaite, Spec Matters
2 days ago

From my research, it looks like polyethylene vapor barriers are not very toxic. However, they end up in landfills and cannot be recycled/reused. Has anyone found better options or healthier alternatives to this?

1 reply Reply

NEW Ice breaker: What's in your ice melt? Community Discussion

Cassidy Clarity, Materials Researcher, Healthy Building Network
5 days ago


It's February in Minnesota and the walkways around my house have turned to ice rinks. In the hopes of finding something less harmful for my family (including four-legged members) and the environment, I put together this Pharos comparison of common ice melt ingredients and thought I'd share. This comparison is certainly not comprehensive since many products don't fully disclose their ingredients. For instance, the "pet safe" ice melt I found has several undisclosed ingredients including "non-ioni...

2 replies Reply

HBN KNOW BETTER

Learn More with Tutorials

Pharos

[Comparisons](#) [Common Products](#) [Discussions](#) [Account](#) 

Guided tutorials and webinars help you get the most out of Pharos

Quick tutorials for specific Pharos features

- Compare hazards of multiple chemicals and track changes to their hazard profiles
- Find chemicals with a specific function (e.g. surfactant) or in a product category (e.g. cosmetics)
- Learn about the most common building products types
- Identify safer alternatives in common building product types
- View hazards in the new Pharos like they are displayed in the old Pharos
- View All Tours

Webinar recordings to learn more about Pharos

- Pharos: Powering a Virtual Learning Experience - [Recording and Slides](#)
- Using Pharos to Power Chemical Management - [Recording and Slides](#)
- Powering Platforms and Data Systems with Pharos - [Recording and Slides](#)
- Getting the Most Out of Pharos - [Recording and Slides](#)

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Pricing options

Annual \$500	Monthly \$75	Weekly \$30	Daily \$10	Discussions Only Free
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Discounts available

- Nonprofit, academic, and government users
- Multiple users
- Scholarships for students, classrooms, or other individuals with financial hardship (scholarships@healthybuilding.net)

Data services



Directly connect your company's data to Pharos via an Application Program Interface (API) and always have up to date information.



Generate custom Data Downloads from our system to power your internal chemicals management programs.

Thank you!

support@pharosproject.net

Center for Green Chemistry & Green Engineering at Yale



Pharos in the

Fundamentals of Green Chemistry & Green Engineering

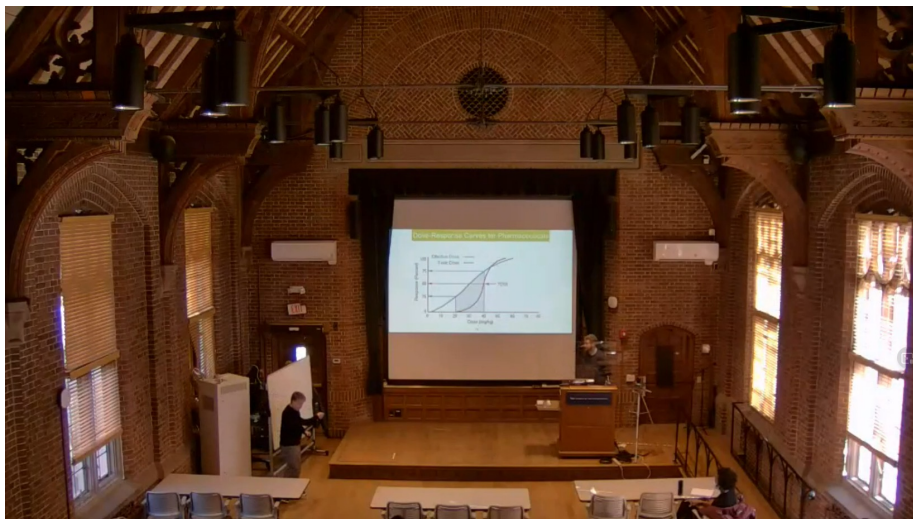
Classroom: Designing Safer Spaces and Products

Dr. Hanno Erythropel

Lecturer & Associate Research Scientist

Fundamentals of Green Chemistry & Green Engineering

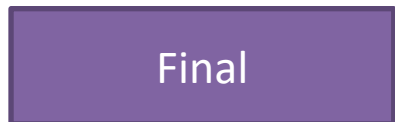
- Offered at the Yale School of the Environment
- Class size: 21 (early 2022: Omicron... hybrid)
- Mix of graduate & undergraduate students
- Backgrounds:
 - Chemical Engineering
 - Environmental Management
 - Public Health
 - Chemistry



Fundamentals of Green Chemistry & Green Engineering

Goals of the class include:

- Approaches and tools to assess the potential hazards of chemical & materials and how to redesign them to eliminate or minimize the hazards
- How chemistry and engineering can help address global human health and environmental issues.
- Students performed **assessments** of chemicals & materials, to inform the **design and innovation** of sustainable solutions alongside an industrial partner

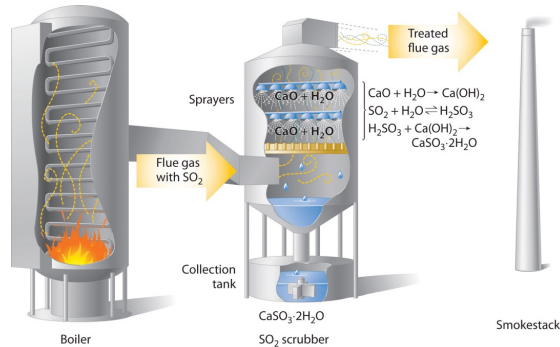


Brief Background: Risk: Exposure Control

$$\text{Risk} = f(\text{Hazard, Exposure})$$

Currently: Focus on exposure mitigation (circumstantial vs. inherent)

What if exposure control fails? Risk ↑↑



Here: Scrubbers for sulfur,

PPE



Brief Background: Risk: Green Chemistry Approach

$$\text{Risk} = f(\text{Hazard, Exposure})$$

Green chemistry is “*the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances”.*

- If the **intrinsic** hazard ↓ : risk ↓
- Ideal case: exposure control needed?



Types of Hazards

$$\text{Risk} = f(\text{Hazard, Exposure})$$

Table / 6.1

Hazard Categories and Examples of Potential Hazard Manifestations

Human Toxicity Hazards		Environmental Toxicity Hazards	Physical Hazards	Global Hazards
Carcinogenicity	Immunotoxicity	Aquatic toxicity	Explosivity	Acid rain
Neurotoxicity	Reproductive toxicity	Avian toxicity	Corrosivity	Global warming
Hepatotoxicity	Teratogenicity	Amphibian toxicity	Oxidizers	Ozone depletion
Nephrotoxicity	Mutagenicity (DNA toxicity)	Phytotoxicity	Reducers	Security threat
Cardiotoxicity	Dermal toxicity	Mammalian toxicity (nonhuman)	pH (acidic or basic)	Water scarcity / flooding
Hematological toxicity	Ocular toxicity		Violent reaction with water	Persistence / bioaccumulation
Endocrine toxicity	Enzyme interactions			Loss of biodiversity



Example of Using Pharos Tool: Homework Assignment

Diacetyl is a compound widely used as flavoring in food and beverages [1]. Diacetyl gives a distinct ‘butter’ flavor, and was extensively added to popcorn. The FDA classifies diacetyl as a generally recognized as safe (GRAS) ingredient, and diacetyl occurs naturally in low concentrations in some foods such as butter, coffee or honey. In 2000, clusters of severe lung disease (bronchiolitis obliterans) in popcorn manufacturing workers occurred and were eventually associated with inhalation of diacetyl. Studies evidenced that popcorn could expose a consumer to 5,700 times the amount of diacetyl present in normal butter [1]. **Eventually, manufacturers turned to substitute diacetyl butter flavoring with another compound, 2,3-pentadione. Use the Pharos tool to assess whether you agree with the replacement and justify your reasoning.**

[1] Rigler, M. W., & Longo, W. E. (2010). Emission of diacetyl (2, 3 butanedione) from natural butter, microwave popcorn butter flavor powder, paste, and liquid products. *International journal of occupational and environmental health*, 16(3), 291-302



[Link](#)

Example of Using Pharos Tool: Homework Assignment

Chemical	Group I Human					Group II and II* Human						Ecotox			Fate		Physical		Mult			
	C	M	R	D	E	AT	ST	ST	N	N	SnS	SnR	IrS	IrE	AA	CA	ATB	P	B	Rx	F	Mult
Diacetyl 431-03-8	M	-	-	M-L	-	M	pC	pC	-	-	H	-	H	vH	-	-	-	vH-H	-	-	H	vH
2,3-Pentanedione 600-14-6	-	-	-	H-L	-	pC	pC	pC	-	-	pC	-	H	H	-	-	-	vH-H	-	-	H	U

- Do you agree with the replacement ?
 - No: 14 / Yes: 1 (“Based on provided knowledge and disregarding other options”)
- For students with no toxicology background:
 - “Simple” to grasp and assess knowledge on chemical compounds
 - Not a black box: Sources available, quantifiable + PubMed?!



[Link](#)

Example of Using Pharos Tool: Homework Assignment

Since the early 1970s, polybrominated diphenyl ethers (PBDEs) were extensively added to consumer goods, successfully preventing ignition or retarding fire spread [2]. One of these compounds is **decabromodiphenyl ether (decaBDE)**. In 2017, decaBDE was added to the Stockholm convention, with exemptions for uses in building materials or textiles that require anti-flammable characteristics. A wide range of phosphorus based flame retardants, already on the market, were proposed as alternatives for decaBDE, such as tris(2-chloroisopropyl)phosphate (TCIPP), which is an alternative produced in large amounts in the US (50-100 million lbs. in 2015). **Use Pharos to assess whether the replacement is a good decision and justify your reasoning.**

[2] Blum, A., Behl, M., Birnbaum, L. S., Diamond, M. L., Phillips, A., Singla, V., ... & Venier, M. (2019). Organophosphate ester flame retardants: are they a regrettable substitution for polybrominated diphenyl ethers?. *Environmental science & technology letters*, 6(11), 638-649. <https://doi.org/10.1021/acs.estlett.9b00582>



[Link](#)

Example of Using Pharos Tool: Homework Assignment

Chemical	Group I Human					Group II and II* Human								Ecotox			Fate		Physical		Mult	Non-GSLT			
	C	M	R	D	E	AT	ST	ST	N	N	SnS	SnR	IrS	IrE	AA	CA	ATB	P	B	Rx	F	Mult	PBT	GW	O
Decabromodiphenyl ether 1163-19-5	H-L	M	-	H-M	H-M	pC	-	-	H	vH-M	-	-	M	M	-	-	-	vH-H	pC	-	-	M	U	-	-
Tri-(2-chloroisopropyl)phosphate 13674-84-5	DG	L	M	M	M	L	NA	L	NA	M	L	DG	L	M	H	M	-	vH	vL	L	L	-	-	-	-

- Do you agree with the replacement ?
 - No: 1 / Unsure: 1
- For students with no toxicology background:
 - Often: Not an obvious decision, but trade-offs needed. For example, between
 - Routes of exposure
 - Gaps in knowledge
 - Hazard level
 - ...



[Link](#)

Fundamentals of Green Chemistry & Green Engineering

Goals of the class include:

- Approaches and tools to assess the potential hazards of chemical & materials and how to redesign them to eliminate or minimize the hazards
- How chemistry and engineering can help address global human health and environmental issues.
- Students performed **assessments** of chemicals & materials, to inform the **design and innovation** of sustainable solutions alongside an industrial partner



Example of Using Pharos Tool: Alternatives Assessment

Chemical	GS	Group I Human					Group II and II* Human							Ecotox			Fate		Physical		Mult		Non-GSLT				
		C	M	R	D	E	AT	ST	ST	N	N	SnS	SnR	IrS	IrE	AA	CA	ATB	P	B	Rx	F	Mult	PBT	GW	O	Other
Ethylene 74-85-1	LT-UNK	M	-	-	-	-	pC	pC	-	M-L	vH-M	-	-	-	-	M	-	-	-	-	-	H	M	-	-	-	R
Polyethylene 9002-88-4	LT-UNK	H-L	-	-	-	-	-	-	-	-	-	M	-	-	-	-	-	-	vH-H	-	-	-	-	-	-	R	
POLYHYDROXYBUTYRATE 26744-04-7	NoGS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Poly((R)-3-hydroxybutyric acid-co-(R)-3- hydroxyhexanoic acid) 198007-37-3	NoGS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R	

Figure 3: Pharos Comparison

From a midterm report comparing polyethylene (PE) packaging to polyhydroxy alkanooate (PHA) polymers in collaboration with an industrial partner.

Here: Students based their toxicity/fate/flammability comparison on Pharos data.

* One could have included the monomers (building units) of the bottom 2 polymers



Example of Using Pharos Tool: Alternatives Assessment

Chemical	Group I Human						Group II and II* Human						Ecotox			Fate		Physical		Mult		Non-GSLT					
	GS	C	M	R	D	E	AT	ST	ST	N	N	SnS	SnR	IrS	IrE	AA	CA	ATB	P	B	Rx	F	Mult	PBT	GW	O	Other
Ethylene 74-85-1	LT-UNK	M	-	-	-	-	pC	pC	-	M-L	vH-M	-	-	-	-	M	-	-	-	-	-	H	M	-	-	-	R
Polyethylene 9002-88-4	LT-UNK	H-L	-	-	-	-	-	-	-	-	-	M	-	-	-	-	-	-	vH-H	-	-	-	-	-	-	-	R
POLYHYDROXYBUTYRATE 26744-04-7	NoGS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Poly((R)-3-hydroxybutyric acid-co-(R)-3- hydroxyhexanoic acid) 198007-37-3	NoGS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	R

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In Conclusion: Pharos

- Easily accessible platform to non-toxicology majors
- Data is aggregated into scores, but sources are transparent (both legislation & academic literature)
- Nuances in evaluating alternatives can be incorporated by carefully selecting non-obvious comparisons (e.g., flame retardant example)
- Very helpful tool for Green Chemistry & Green Engineering, where systems thinking is important to generate truly sustainable solutions



Don't hesitate to reach out!



Yale School of the
Environment



Center for Green Chemistry &
Green Engineering at Yale

Advance Science

Catalyze
Implementation

Prepare the next
generation

Raise Awareness

✉ Hanno.erythropel@yale.edu

greenchemistry@yale.edu

🌍 www.greenchemistry.yale.edu

🐦 Twitter: **@YaleGCGE**

📘 Facebook: Center for Green Chemistry & Green Engineering

🎵 We'll get there!





Using Pharos to Investigate Building Material Ingredients and Chemical Sensitivities

Presented by: Bobby Ilg, OAA, MRAIC, BBNC, M.Arch, B.E.D.

Bobby Ilg

Graduated from U of M BED program in 2000

Graduated from Carleton U M. Arch. in 2005

Part-time Professor at Algonquin College

Bachelor of Interior Design

Principal Architect of Build Well to Be Well

Discovered Building Biology and introduced to Algonquin College

First Collaboration between the Building Biology Institute and Academic College

Built his own panelized clay/straw home

Continues to evolve panel system and building with clay based and natural materials





Algonquin College – Bachelor of Interior Design & Building Biology Institute Collaboration

Building Biology Advocate (BBA) Educational Certification:

BBA course material provided by the Building Biology Institute

- IBE 101 Course (300 page course with study manual)
- 7 on-line courses that students complete on BBI website
- Building Biology education integrated into BID curriculum

Building Biology Education Specialist (BBES) Certification for all professors (Educating the Educators)

Yearly Membership for Enrolled Students (Minimum Yearly Fees) with access to BBI on-line library and network connections with the Building Biology Community and Specialists



Building Biology
recognizes that

Nature *is* the Gold Standard
for a healthy human
environment *and* the
ultimate model for perpetual
ecological balance.



Building Biology is unique on its emphasis on human health with the perspective that “there is almost always a direct correlation between the biological compatibility of any building material and its ecological performance.” In other words, that which is truly healthy for us will also be healthy for the environment.



Is there a successful **history** of use?



Humans have always created durable shelter, within the closed circuit of nature, no waste, no pollution, using the natural materials at hand ...until very recently

1200AD to 2016+





Accommodating a Growing Segment of the Population

“What is striking about Multiple Chemical Sensitivities (MCS) is its prevalence. The Canadian Community Health Survey shows prevalence figures of 599,000 people in 2005.....and in 2016, just over 1,000,000 people are affected by MCS in Canada”

<https://seriouslysensitivetopollution.org/statistics-for-mcses-fm-and-mecfs/>



Lucky Charms

Nutrition Facts

Serving Size: 1 (0.75 cup, 27 grams)

Amount Per Serving

Calories 110 Calories from Fat 9

% Daily Value*

Total Fat 1g 2%

Saturated Fat 0g 0%

Trans Fat 0g

Cholesterol 0mg 0%

Sodium 190mg 8%

Total Carbohydrate 22g 7%

Dietary Fiber 1g 4%

Sugars 11g

Protein 2g 4%

Calcium

* Percent Daily Values are based on a 2,000 Calorie diet. Your daily values may be higher or lower depending on your Calorie needs.

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

*Calories per gram:

Fat 9 Carbohydrate 4 Protein 4

If homes had labels.....



How do we decide what makes it healthy?



greenprojectmarketing.com

Foam insulation



www.sheepwoolinsulation.net

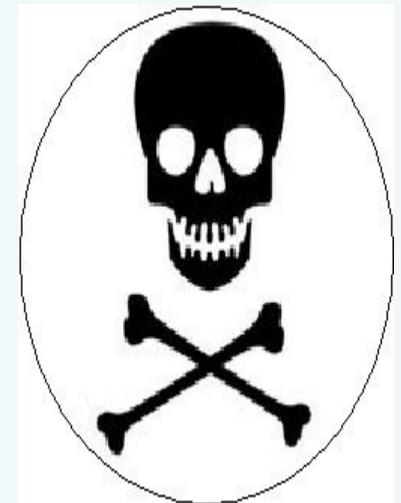
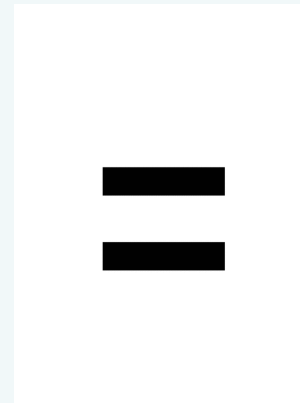
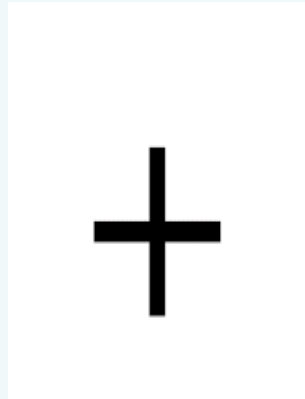
Wool batts

Staying Informed – Swiftly Moving Target





1 + 1 = ?
1 + 1,000 = ??





Making Sense of Chemicals for the Non-Chemist



We have accessed Pandora's box

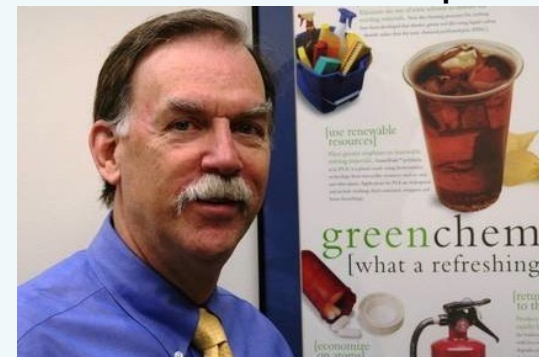
Periodic Table of the Elements

1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.933	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.732	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.09	35 Br Bromine 79.904	36 Kr Krypton 84.80
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.29
55 Cs Cesium 132.905	56 Ba Barium 137.327	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinides	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown
57 La Lanthanum 138.906	58 Ce Cerium 140.115	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.966	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967			
89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]			

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sciencenotes.org

The 85,000+ man-made chemicals approved for commerce derive from roughly 88 of the elements found on the periodic table.

Dr. Robert Peoples



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Making Sense of Chemicals for the Non-Chemist



Nature the Gold Standard 5 billion year track record!

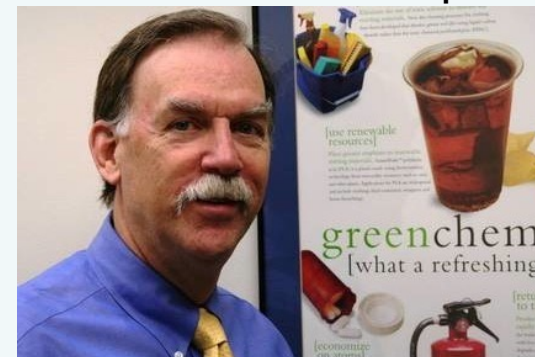
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All of the functions and services delivered by living systems found in nature in our environment are result of use of these twelve chemicals in periodic table.

Dr. Robert Peoples



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The Six Classes Approach



“There are more than 80,000 untested chemicals in use today. Many of the most problematic substances in everyday products are from six families or “classes” of chemicals. When a compound is from one of these classes, we should ask, “Do we really need this chemical? Is it worth the risk?””



The Building Biology Vetting Assignment



Four Step Building Biology Vetting Process:

Step One: Check a manufacturer's information

Step Two: Is the product certified?

Step Three: Find the ingredient list

**Step Four: What are the health properties /
hazards of ingredients
*- research using Pharos database***



Pharos



Common Products

- *breakdown of ingredients in common building materials*
- *great database for students and professionals in the building industry*

Hazard List Summary

- *overview of potential hazards for individual ingredients*
- *based on global research / databases*
- *includes both human and environmental hazards*
- *important to determine if hazards are during construction or after clients occupy the space*

Student Summary

- *students must use the various results from the Pharos investigation to determine possible health risks for the materials they are proposing to use in their associated studio projects.*

Applying Building Biology Principals



QUÉBEC VEUT INTERDIRE LE CHAUFFAGE AU MAZOUT

LA

MAISON



DU 21^e SIÈCLE

SAINE ET ÉCOLOGIQUE



ÉCO NID ARGILE- PAILLE

SUBVENTIONS
ÉCOÉNERGÉTIQUES

+
L'ÉLECTRICITÉ
SOLAIRE ET
LA SANTÉ
ÉTANCHEITÉ
À L'AIR
TÉLÉTRAVAIL
INNOVANT

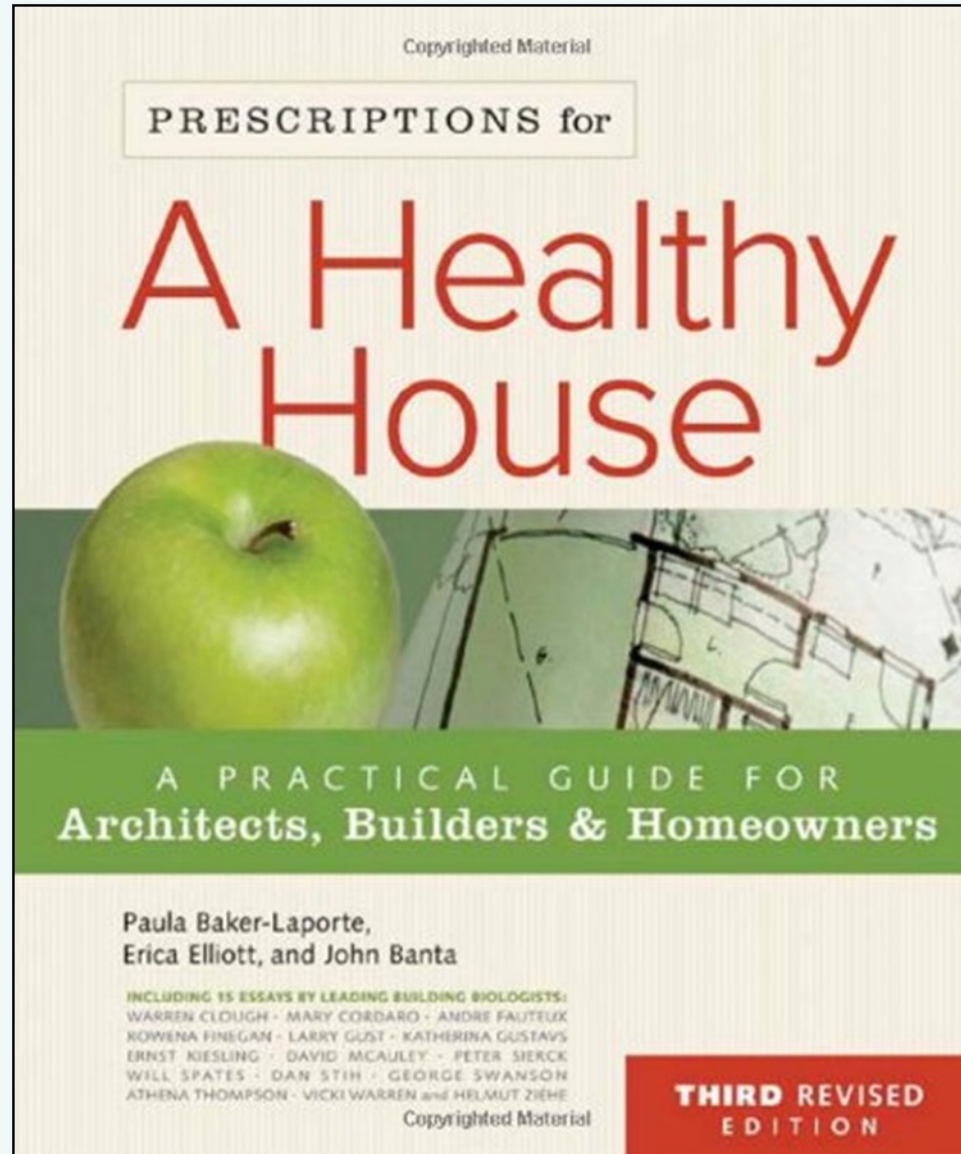
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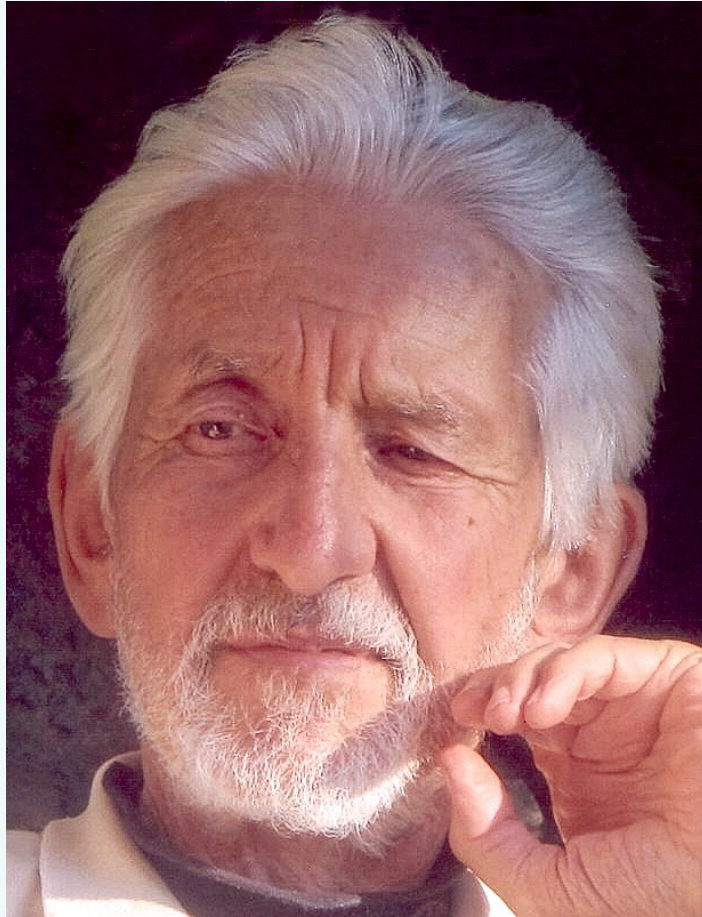
Métagènes Dynamiques

11705 6-455

EN KIOSQUE JUSQU'AU 10 DÉCEMBRE 2021

Toxin-Free ...First Do No Harm!





“A home will be successful to the degree that natural unprocessed building materials are used to create it.”

Anton Schneider



Natural Unadulterated Building Materials





Natural Unadulterated Building Materials





Natural Unadulterated Building Materials





Natural self-regulation of humidity, ionization & acoustics using hygroscopic building materials and finishes





Natural Interior Finishes





Thermal Storage Capacity





Natural Daylight

- Multi-directional
- Diffused
- No glare
- Maximize
Natural light at
all times of day





Natural Daylight





Lighting





**Color and
pattern in
accordance
with nature**





Algonquin College
Build Well to Be Well
BuildWise Clay Systems

Bobby Ilg
bobby@buildhealthy.ca
buildhealthy.ca
613-858-8222

Thank You