The move to Safer Building Materials?

An introduction to the world of toxicology and safety assessment of materials

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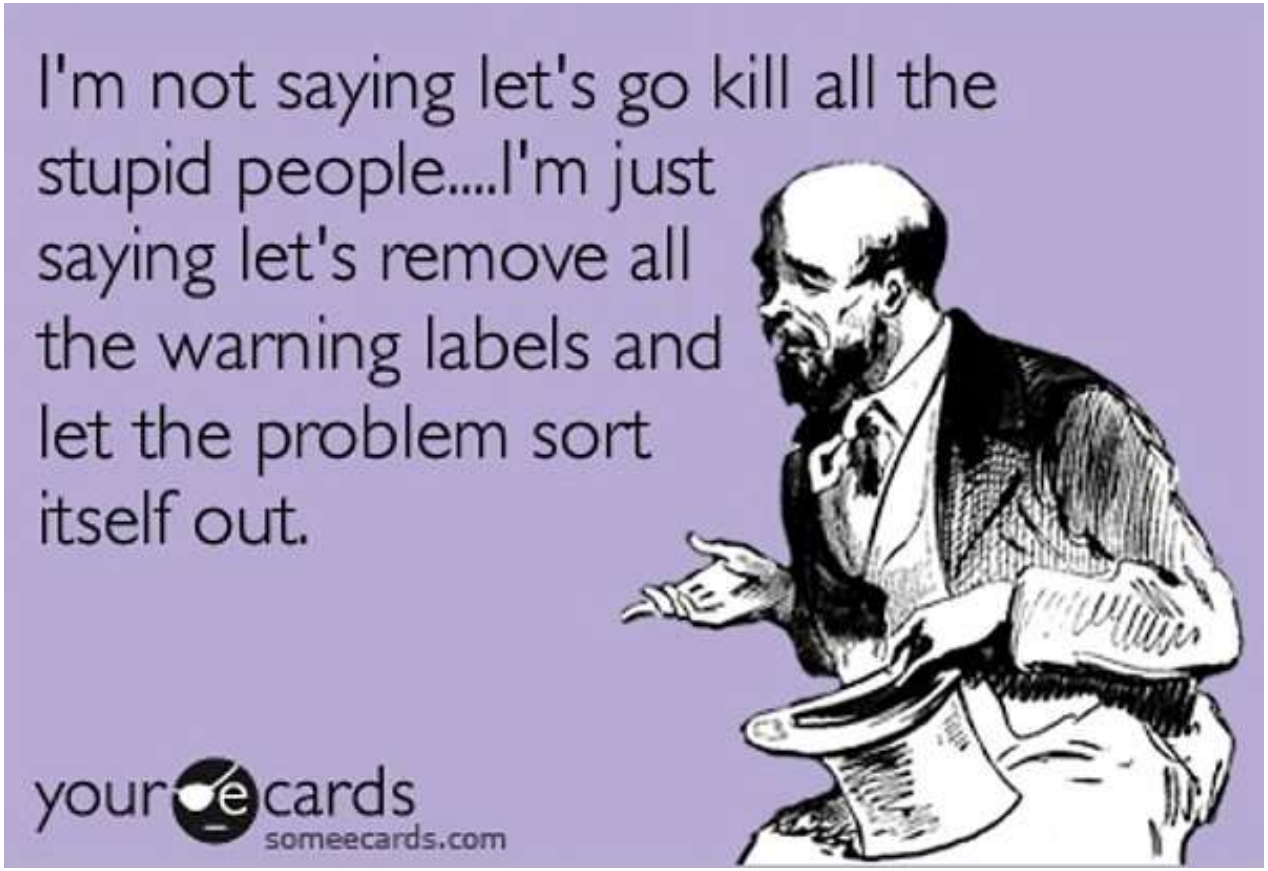
Overview

- A bit of background.
- How does toxicology work? A case study on fibers.
- What is all the talk about nanotechnology?
- The talk about transparency in building materials. Does transparency = safer?
- Assessing product safety. SDS /MSDS
- Summary

A bit of background

- What the heck is a toxicologist?
- Toxicology = the basic study of poisons.
- Everything can be toxic if there is enough of it.
- The dose makes the poison. (~1500 AD)

Just a thought



How does toxicology work?

A case study on fibers

In June of 1987 a group of 20 international scientists met for 8 days at the International Agency for Research on Cancer (IARC), and concluded that fiberglass wool was “possibly carcinogenic to humans”.

14 Years Later…

In October 2001, a group of 19 international scientists met for 8 days at the International Agency for Research on Cancer, and concluded that glasswool was no longer considered a possible carcinogen.

Background on the fiber issue.

- A bit of history – why was fiberglass on the IARC list ?
- The science of fiber safety –understanding the critical role of fiber durability
- Assured Fiber Safety

History

- Asbestos fibers associated with disease in man: asbestosis, lung cancer and mesothelioma.
- Injection studies of fiberglass in early 1970’s.
- Concerns raised about possible health effects.

History

- IARC listed fiberglass as possible carcinogen (1987).
- IARC listing sparked intensive research.
- Led to understanding of key mechanisms responsible for the potential health effects of fibers.

Traditional view of fiber safety: The Three D's

- **Dose:** How much in the air ?
- **Dimension:** How big are the fibers?
- **Durability:** How long do they stay in the lung?

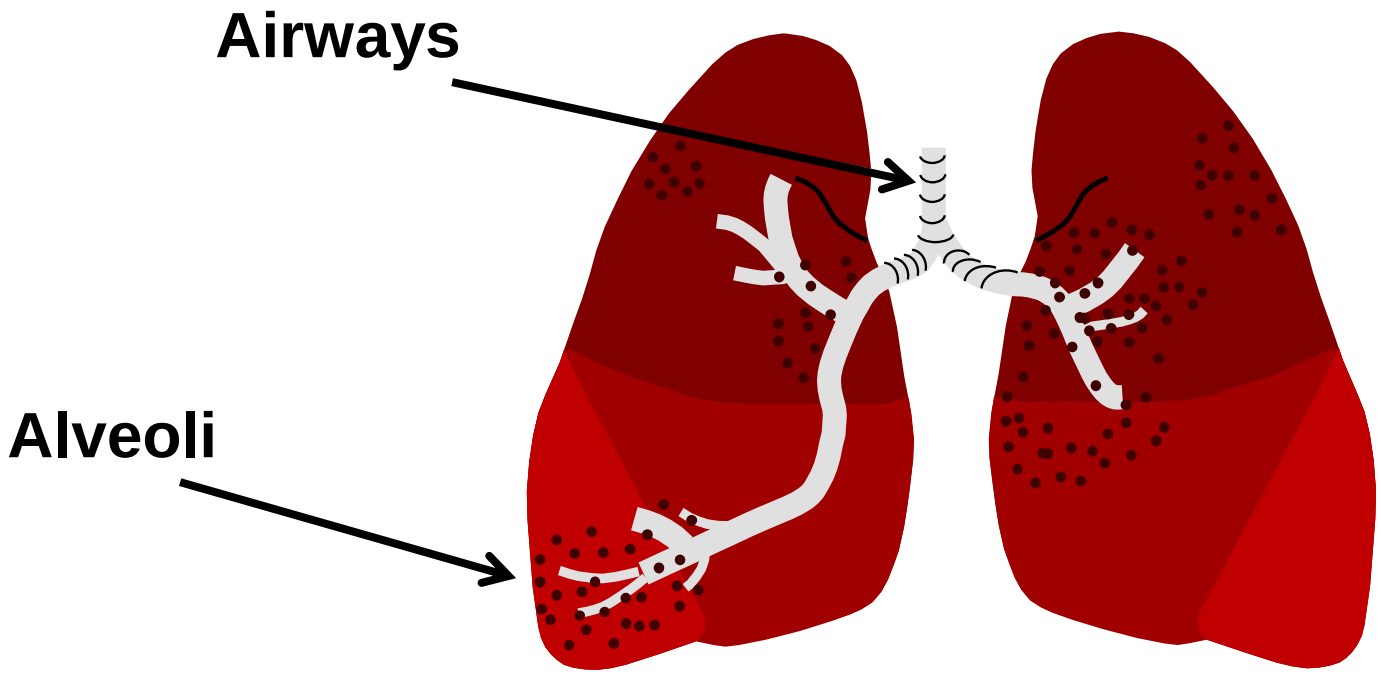
Pulmonary Clearance and Inhaled Fibers

- Lung structure prevents large particles of dust from entering the gas exchange region of the lung.
- The dimensions of particles that get in the lower lung allow for removal by alveolar macrophages.
- Except for the fibers.

What’s the deal with fibers?

This requires us to think a bit about the human lung

Human Lung



The alveolar macrophage:

- Macrophage -“Great Eater”
  (the great white shark of the deep lung)
  Humans have about 6 billion at any one time.
- Filled with very potent digestive enzymes.
- If damaged in large numbers, will lead to inflammation, and possibly other chronic effects.

Pulmonary Clearance and Inhaled Fibers

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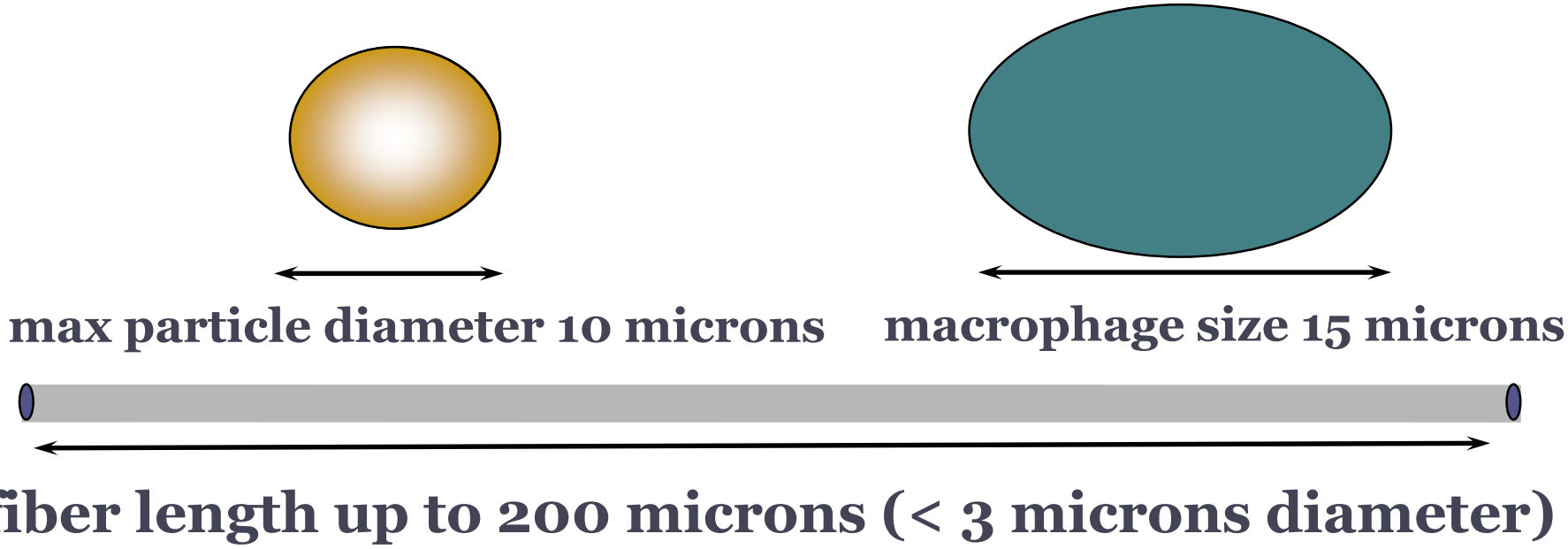
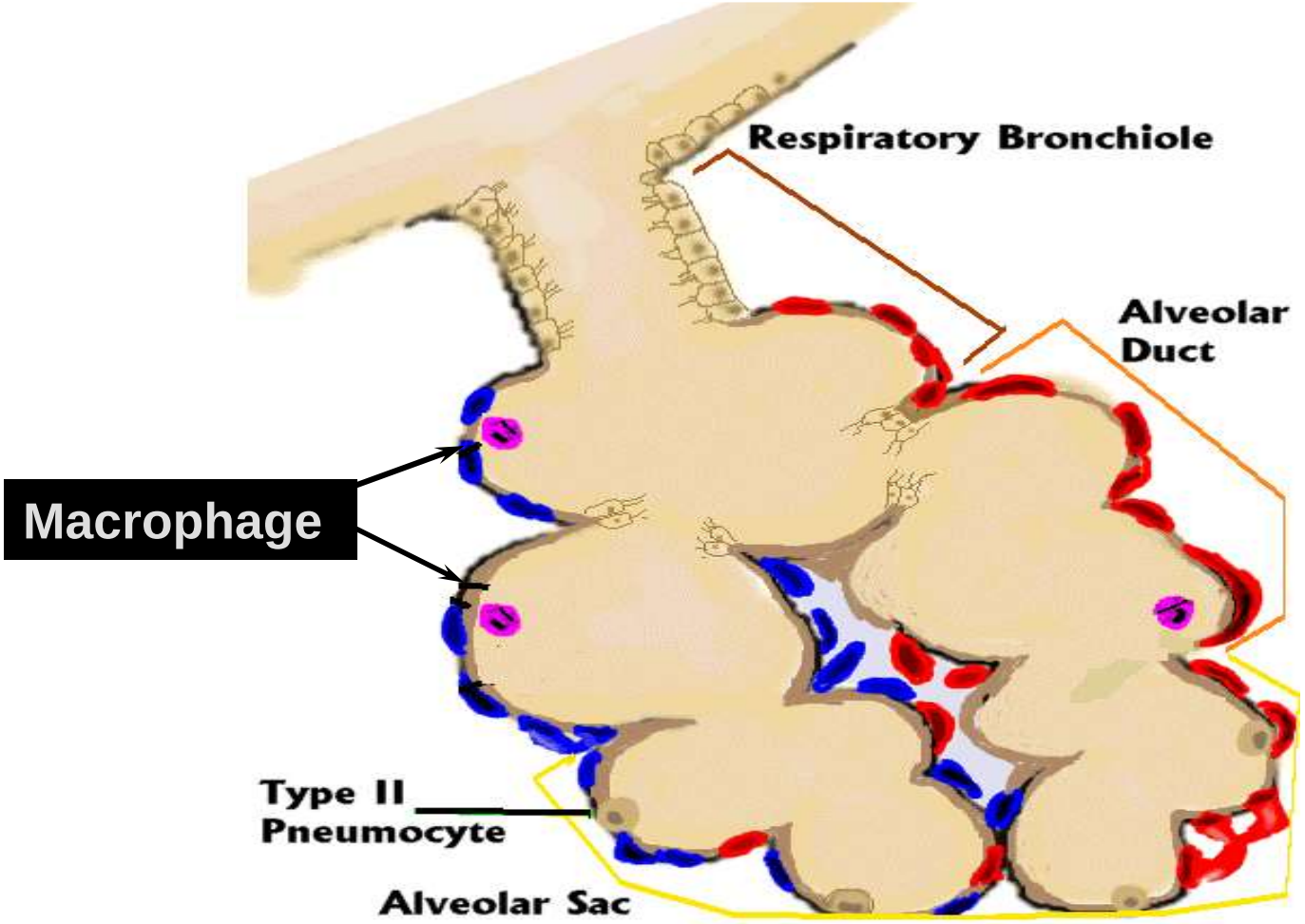
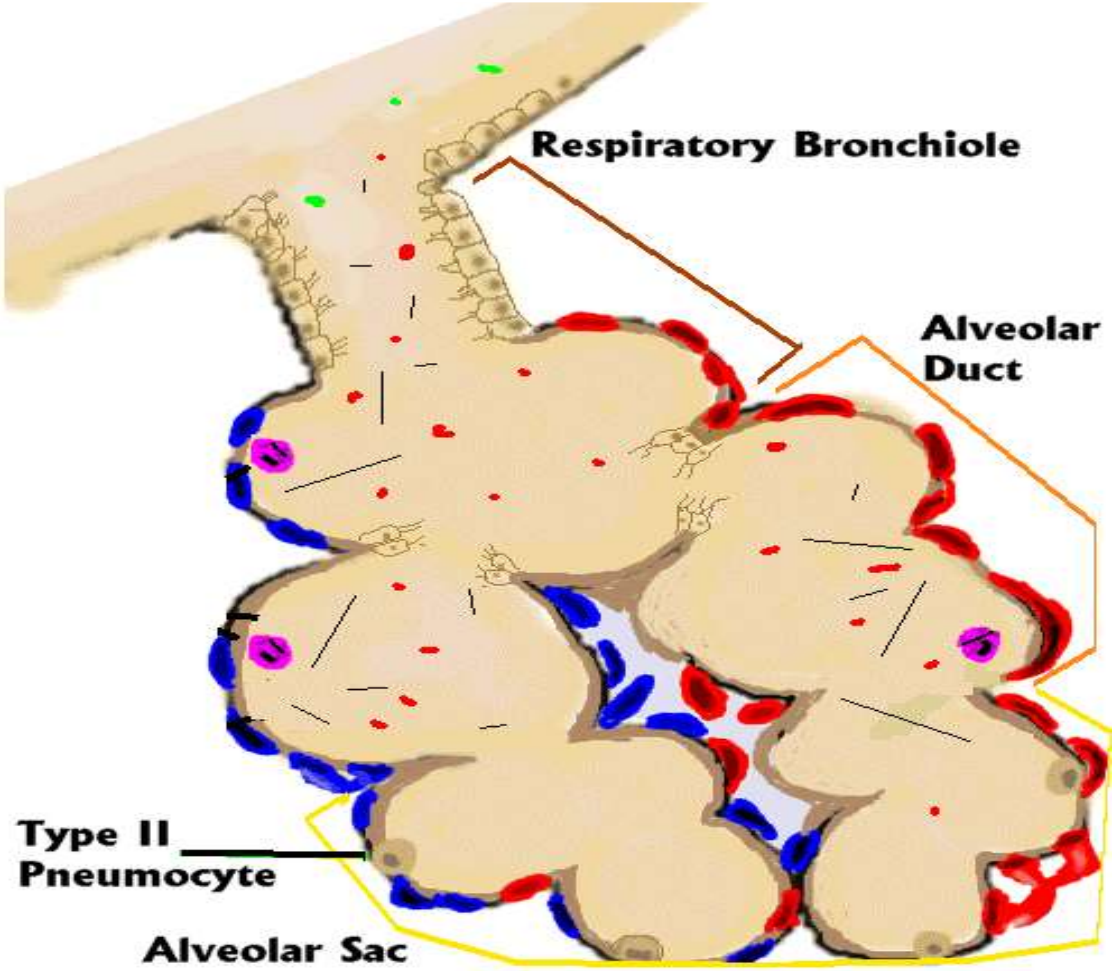
Dimensions - Key to Deposition and Clearance



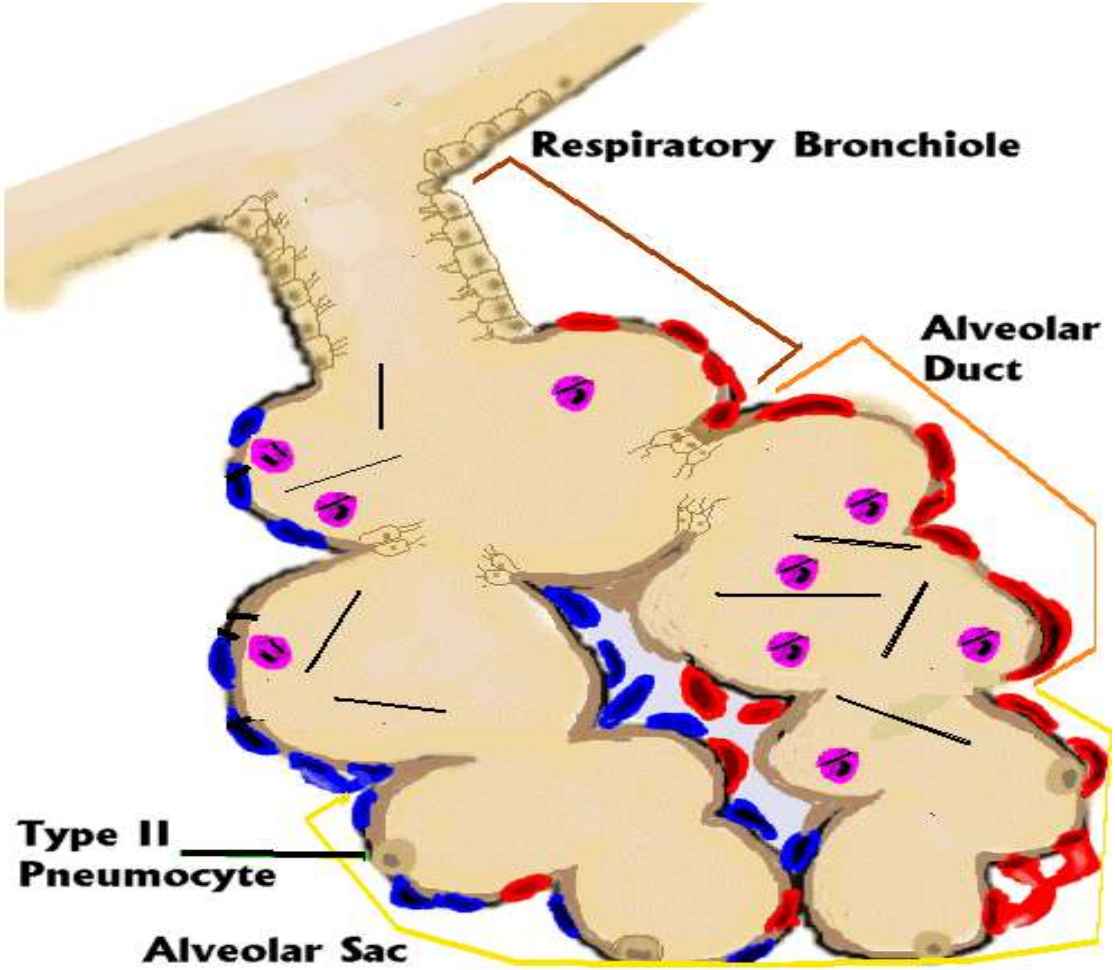
In the non exposed lung, one or two macrophages reside in each alveolus in a near sterile environment.



Exposure

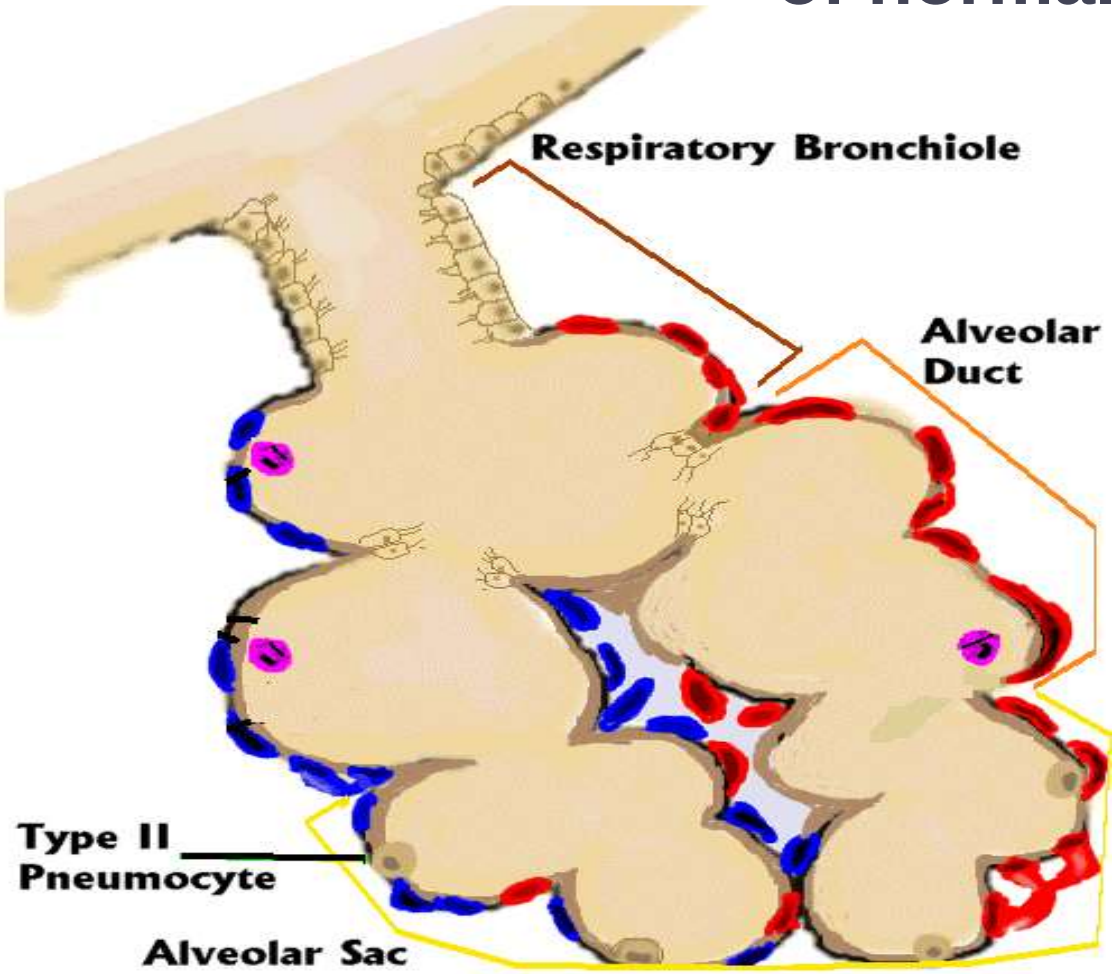

Respiratory Bronchiole
Alveolar Duct
Type II Pneumocyte
Alveolar Sac

Early Clearance of small particles and short fibers



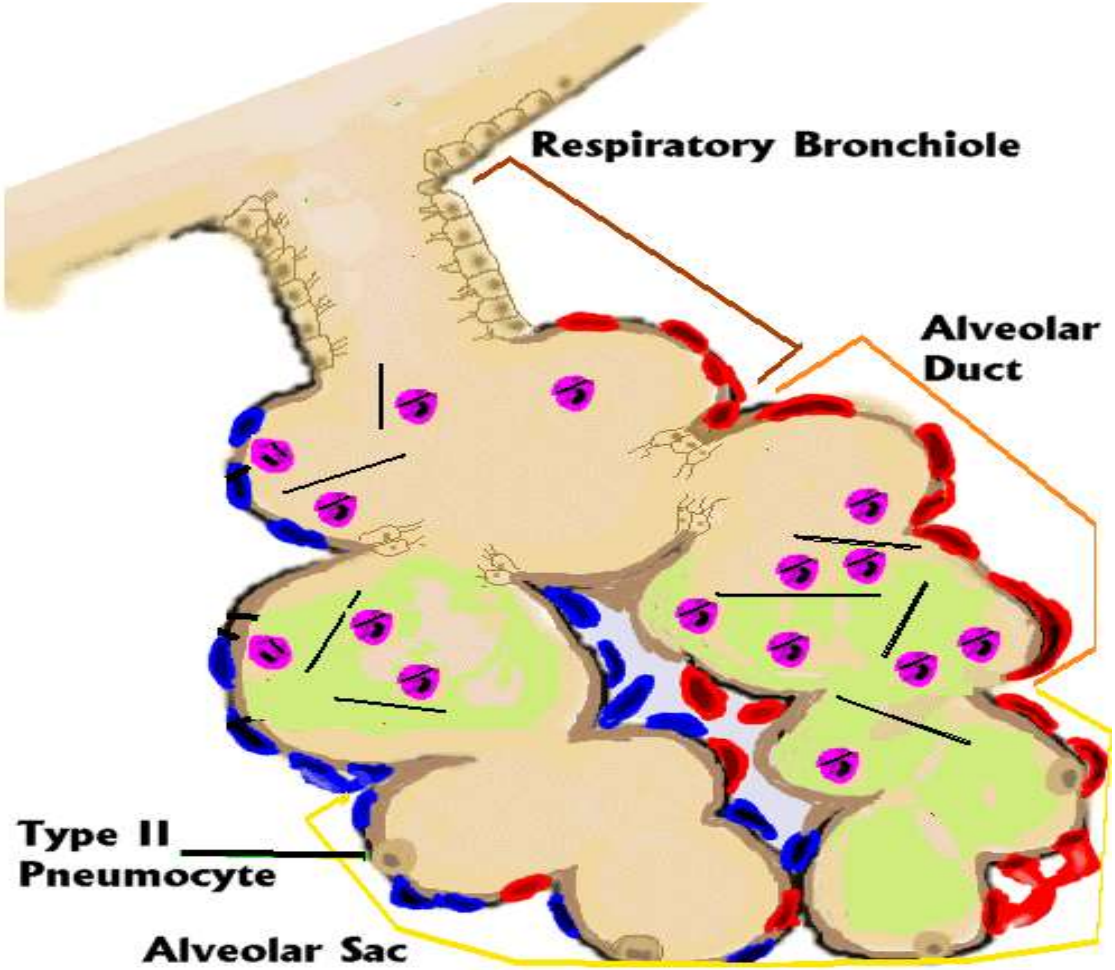
Soluble long fibers

Rapid recovery of normal



Durable long fibers

chronic inflammation



The unique role of fiber durability - Key concepts

- Aerodynamics leads to the deposition of fibers which cannot be removed efficiently by macrophages.
- If durable, at high concentrations, the long fibers will lead to disease, regardless of the type of fiber.
- Removal of long fibers is a function of their dissolution rate which is controlled primarily by composition.

The result of the research

- 2001 IARC removes fiberglass wool from list of Possible Carcinogens.
- 2011 US Gov removes soluble fiberglass wool from list of materials “Reasonable Anticipated to Cause Cancer”.
- 2011 California removes soluble fiberglass insulation from list of substances “Known to the State of California to cause cancer”.

Classification of Fibers

	Respirable	Non respirable
Soluble		If fibers are non respirable, their durability is unimportant
Durable	Must be evaluated for biological activity if exposure exceeds 0.05f/cc	

Beware of scuba divers crossing the road!

What’s all the talk about Nanotechnology?

Overview of the nano issue

- Background
- Size of stuff
- Toxicity concerns
- Regulatory-MSDS’s

Size of stuff

- Nanomaterials considered to be 100 nanometers or less. (0.1 micron)
- Human hair: 60-80 microns
- Largest respirable particle: 10 microns
- Red blood cell: 7 microns

Natural nanoparticles

- Have been around since the first fire.
- Common source is combustion.
- About half of air pollution is nano sized.
- Lots of nanoparticles everywhere.
- Carbon nanotubes formed from gas ranges

Urban Ultrafine Particle Concentrations (particles per cc)

- Suburban Residential (sleeping) 2,000
- Urban Office 5,000
- Urban Outdoor 20,000
- In-vehicle (arterial road) **50,000**
- In-vehicle (freeway) 150,000

- (500 cc per breath/12 breaths per minute)

The Nano Issue

- Nanomaterials currently used in multiple applications.
- Multi billion dollar industry estimated to be near 1 trillion dollars globally by 2015.
- Health/safety Information limited, confusing and heavily marketed.

The Media and Nanotechnology

- “Magic Nano”
  - Aerosol spray treatment to make glass/ceramic water and dirt repellent
  - Around 100 consumers reported respiratory difficulties
  - Product withdrawn from marketplace
  - Implications
    - Galvanizes groups opposed to nanotechnology
    - Hurts small business and startup sectors of nanotechnology

DID NOT CONTAIN NANOMATERIALS !

Regulatory/MSDS's

- No existing guidelines or regulations that capture size.
- Nanomaterials will have same MSDS as bulk material.
- Extensive activity from US Gov agencies.

Toxicity Concerns

- Traditional concepts in inhalation toxicology.
- Unique biological aspects of very small things.
- Couple of early findings fueled concerns.

Summary

- Nanomaterials offer new possibilites in a variety of fields.
- Nanomaterials are part of our everyday lives.
- Unknown potential risks of new engineered nanomaterials.
- Avoiding exposure eliminates risk.

So if you make a mistake the wing falls off?

The talk about transparency in building materials.

Does transparency = safer?

Many “Transparency” documents only identify materials that are determined to be hazards.

- It is critical to understand the difference between something simply being present in a material (Hazard) or the possibility of a chance of a significant exposure to that material (Risk)

Consider the following…

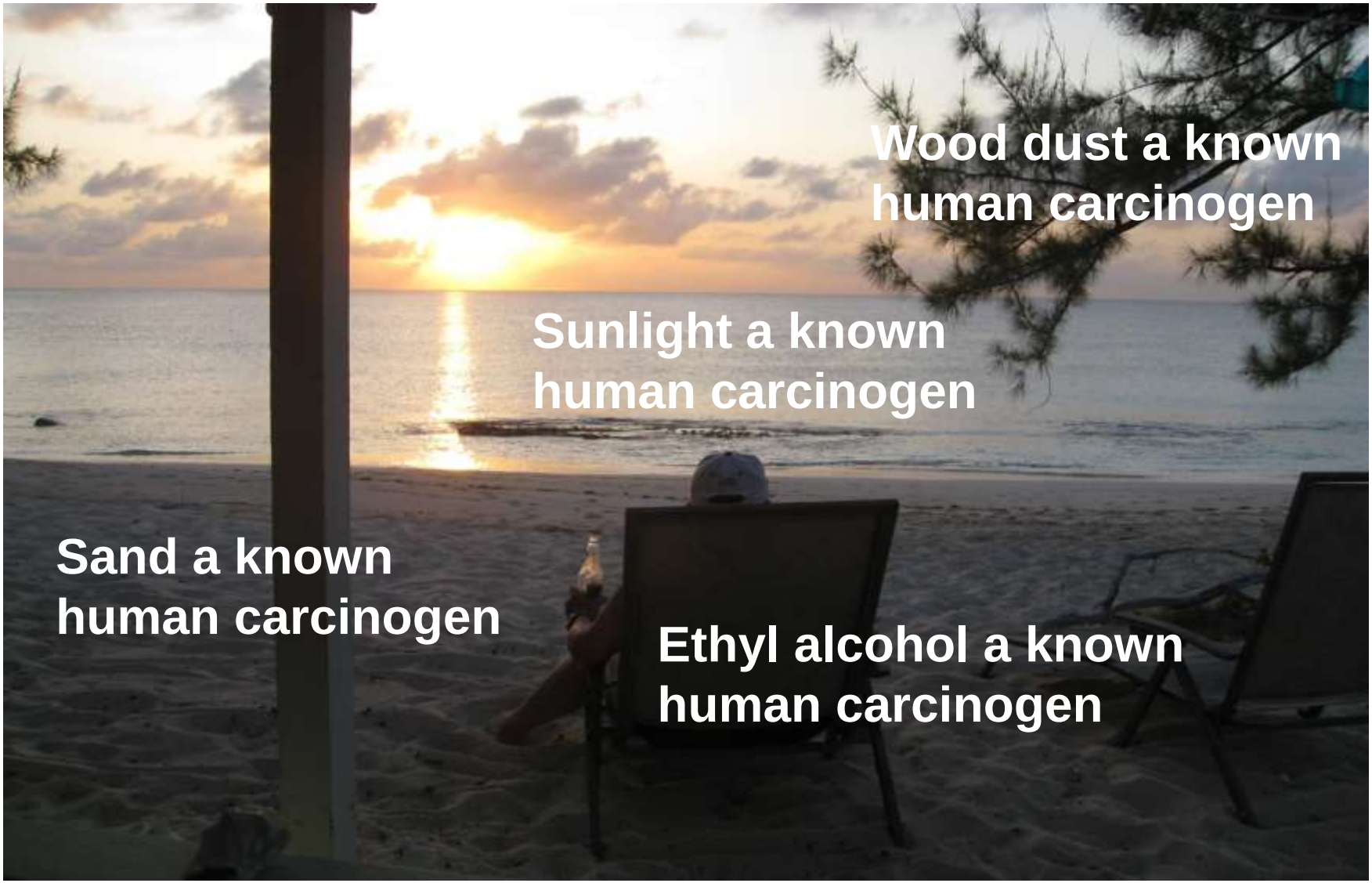
What could be safer?

If we only look at hazards what does a toxicologist see?


Sunlight a known
human carcinogen


Wood dust a known
Human carcinogen
Sunlight a known
human carcinogen


Wood dust a known human carcinogen
Sunlight a known human carcinogen
Sand a known human carcinogen


Wood dust a known human carcinogen
Sunlight a known human carcinogen
Sand a known human carcinogen
Ethyl alcohol a known human carcinogen


Wood dust a known human carcinogen
Sunlight a known human carcinogen
Formaldehyde a known human carcinogen
Ethyl alcohol a known human carcinogen
Sand a known human carcinogen

Hazards or Risks?

Hazard verses Risk.

- **Risk = hazard X possibility of exposure**

Two hungry tigers…
Two equal hazards

Hazard verses Risk

- **One is in a cage at the zoo**

Insignificant Risk

Hazard verses Risk

- **One is in your living room**

Extreme Risk!

How are Hazards determined?

- Frequently a chemical will appear on some list of suspect chemicals and then will be considered a hazard.
- Problem is there are dozens of different lists from Governments, regulatory agencies, and private groups.
- Some of these are authoritative, some are not.

Lists used to identify hazards include many non-vetted lists

- While IARC, NTP, NIOSH, are well recognized and credible list of “hazardous” chemicals, a number of others included are not.
- These unvetted lists can add hundreds of chemicals for which data quality is unknown
- The user of the transparency document has no way to know which of the chemicals is an actual “risk”.
- This can lead to very poor choices.

A simple list of ingredients is not really useful for determining if something is safe:

Consider the following list…

INGREDIENTS: WATER (75%), SUGARS (12%) (GLUCOSE (48%), FRUCTOSE (40%), SUCROSE (2%), MALTOSE (<1%)), STARCH (5%), **FIBRE E460 (3%), AMINO ACIDS (GLUTAMIC ACID (19%),**

ASPARTIC ACID (16%), HISTIDINE (11%), LEUCINE (7%), LYSINE (5%), PHENYLALANINE (4%), ARGININE (4%), VALINE (4%), ALANINE (4%), SERINE (4%), GLYCINE (3%), THREONINE (3%),

ISOLEUCINE (3%), PROLINE (3%), TRYPTOPHAN (1%), CYSTINE (1%), TYROSINE (1%), METHIONINE (1%)), **FATTY ACIDS (1%)**(PALMITIC ACID (30%), OMEGA-6 FATTY ACID: LINOLEIC ACID

(14%), OMEGA-3 FATTY ACID: LINOLENIC ACID (8%), OLEIC ACID(7%), PALMITOLEIC ACID (3%), STEARIC ACID (2%), LAURIC ACID(1%), MYRISTIC ACID (1%), CAPRIC ACID (<1%)), ASH (<1%),

PHYTOSTEROLS, E515, OXALIC ACID, E300, E306(TOCOPHEROL), PHYLLOQUINONE, THIAMIN, **COLOURS** (YELLOW-ORANGE E101 (RIBOFLAVIN), YELLOW-BROWN E160a),**FLAVOURS (3-METHYLBUT-1-YL ETHANOATE, 2-METHYLBUTYL**ETHANOATE, 2-METHYLPROPAN-1-OL, 3-METHYLBUTYL-1-OL, 2-HYDROXY-3-METHYLETHYL BUTANOATE, 3-METHYLBUTANAL,

ETHYL HEXANOATE, ETHYL BUTANOATE,, PENTYL ACETATE),1510, NATURAL RIPENING AGENT (ETHENE GAS).

The list of chemicals would be the ingredients of …

The all natural banana

AN ALL-NATURAL BANANA

INGREDIENTS: WATER (75%), **SUGARS (12%)** (GLUCOSE (48%), FRUCTOSE (40%), SUCROSE (2%), MALTOSE (<1%)), STARCH (5%), **FIBRE E460 (3%)**, **AMINO ACIDS** (GLUTAMIC ACID (19%), ASPARTIC ACID (16%), HISTIDINE (11%), LEUCINE (7%), LYSINE (5%), PHENYLALANINE (4%), ARGININE (4%), VALINE (4%), ALANINE (4%), SERINE (4%), GLYCINE (3%), THREONINE (3%), ISOLEUCINE (3%), PROLINE (3%), TRYPTOPHAN (1%), CYSTINE (1%), TYROSINE (1%), METHIONINE (1%)), **FATTY ACIDS (1%)** (PALMITIC ACID (30%), OMEGA-6 FATTY ACID: LINOLEIC ACID (14%), OMEGA-3 FATTY ACID: LINOLENIC ACID (8%), OLEIC ACID (7%), PALMITOLEIC ACID (3%), STEARIC ACID (2%), LAURIC ACID (1%), MYRISTIC ACID (1%), CAPRIC ACID (<1%)), ASH (<1%), PHYTOSTEROLS, E515, OXALIC ACID, E300, E306 (TOCOPHEROL), PHYLLOQUINONE, THIAMIN, **COLOURS** (YELLOW-ORANGE E101 (RIBOFLAVIN), YELLOW-BROWN E160a), **FLAVOURS** (3-METHYLBUT-1-YL ETHANOATE, 2-METHYLBUTYL ETHANOATE, 2-METHYLPROPAN-1-OL, 3-METHYLBUTYL-1-OL, 2-HYDROXY-3-METHYLETHYL BUTANOATE, 3-METHYLBUTANAL, ETHYL HEXANOATE, ETHYL BUTANOATE,, PENTYL ACETATE), 1510, NATURAL RIPENING AGENT (ETHENE GAS).

All natural banana
Courtesy of James Kennedy
High School Chemistry Teacher
Melbourne, Australia

There is no way to determine what, if any, risk is involved with a product

- Some transparency documents only indicate that one or more chemicals in the product may be on some list.
- There is no way to determine if there is any chance of potential exposure to the listed chemicals or to rate the degree of hazard posed by a listed chemical.
- One could chose a product based on it having fewer listed chemicals without realizing that those few are much more dangerous than those chemicals on a competing product.
- Again leading to a very bad choice.

How to get on a list?

- For a chemical to get on list, there must be some data from research studies to evaluate its potential health effects.
- The problem is that over 80 % of the chemicals in commerce have never been tested for anything.

From Scientific American 2010

- **The Great Chemical Unknown: A Graphical View of Limited Lab Testing**
- Only a tiny fraction of the compounds around us have been tested for safety
- Oct 1, 2010 | By Mark Fischetti
- Chemicals used by US consumers and industry – 50,000.
- Tested – 300

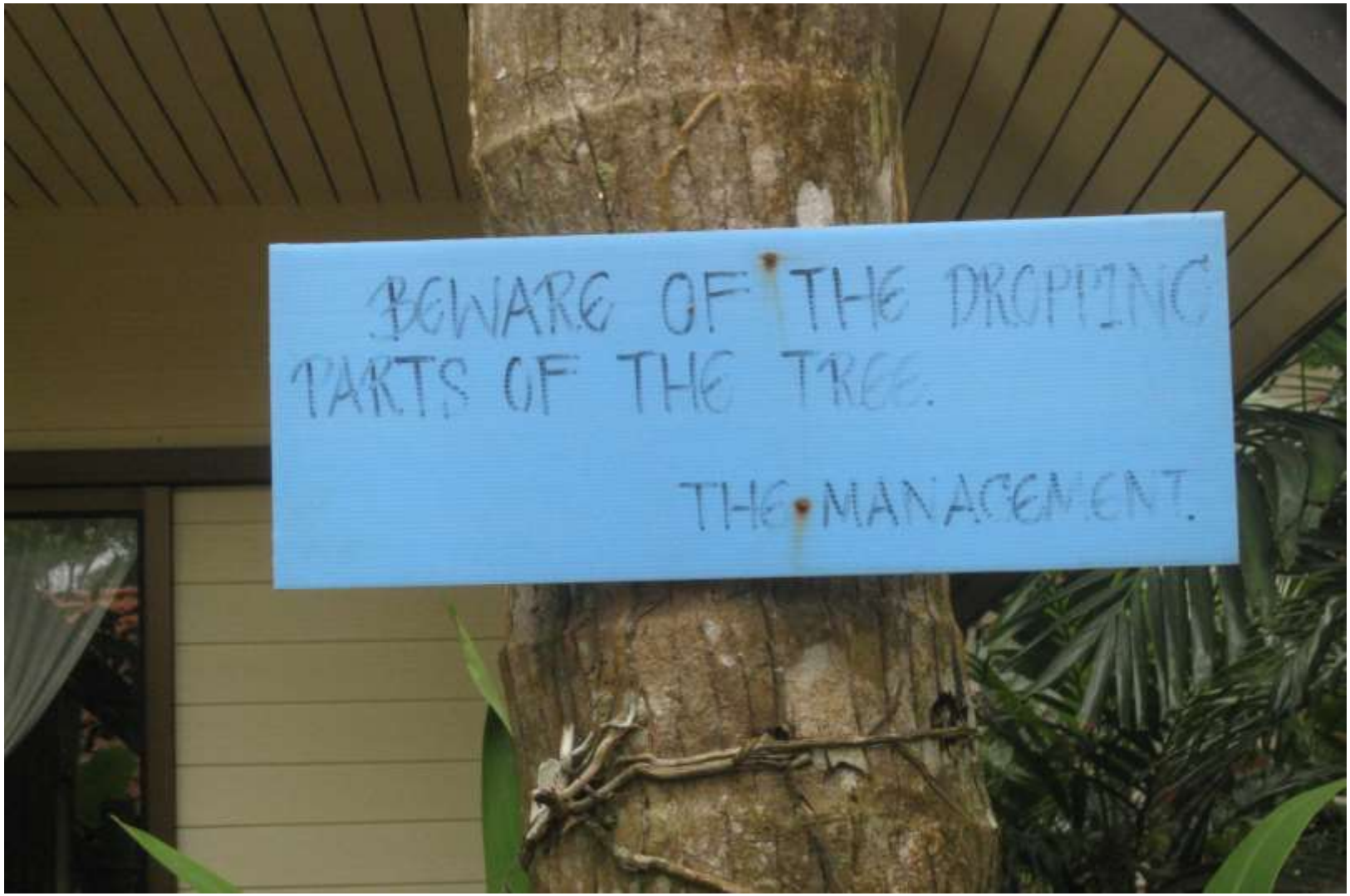
Decision time

Is it better to use a material that may be on a list but risk is well known and controllable?

OR

To use a chemical whose risks are totally unknown?

Yikes, a hazardous risky tree!



Where to find information

- Ask for a MSDS or SDS for the material.
- If unavailable at point of purchase, call or email the manufacturer. They are used to these requests.
- If you have additional questions talk directly to a health and safety person at the manufacturer.

Quick look at MSDS/SDS

- **Section 1 – Identification**
- **Section 2 – Hazard(s) identification**
- **Section 3 – Composition/information on ingredients**
- **Section 4 – First-aid measures**
- **Section 5 – Fire-fighting measures**
- **Section 6 – Accidental release measures**
- **Section 7 – Handling and storage**
- **Section 8 – Exposure controls/personal protection**

MSDS/SDS continued

- **Section 9 – Physical and chemical properties**
- **Section 10 – Stability and reactivity**
- **Section 11 – Toxicological information**
- **Section 12 – Ecological information**
- **Section 13 – Disposal considerations**
- **Section 14 – Transport information**
- **Section 15 – Regulatory information**
- **Section 16 – Other information**

Thinking about “new, improved products”

- For short life span products like dish soap or cleaners, a bit of experimentation may be fine.
- For long life span products such as structural or permanent components of buildings, moving to a new material can prove costly.

New Improved Safer Materials, or not

- Wood product said to be rotting in 'green'-built homes
- **Make It Right is rebuilding parts of about 30 homes after finding that a special type of wood used in construction isn't holding up.**
- **BY RICHARD THOMPSON**
- Dec. 30, 2013 The New Orleans Advocate

Summary

- The field of toxicology is interesting but like all science progresses slowly.
- Removing the cancer question on glass fibers took 25 years!
- Nanotechnology is massively hyped, and poorly understood at the present time.

Summary

- The move to “Transparency” is well intentioned but most current schemes do not offer better information than legally required and regulated documents such as the MSDS or SDS of the product.
- Do not hesitate to contact manufacturer if you have additional questions.
- Likely best to watch a long lifespan product perform in the field for a few years to assess its usefulness.

- Contact information:

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