There are ~3000 chemicals produced in volumes exceeding 1 million pounds per year.

Yet only about a dozen have been investigated for their effects on the developing brain.

At least 75,000+ chemicals are used extensively and 43,000,000+ are cataloged.

Approximately 1,000 new chemicals are introduced each year.

Inadequate data exists regarding the chronic (long term, low level) health risks of most chemicals.

A developing brain is vulnerable to permanent impairment.

Currently 1 in 6 children have some kind of neurodevelopmental disability
The effect of a 'dose' is not so simple.

"The dose makes the poison" insists that large doses always have greater effects than small doses.

But that simplistic approach overlooks greater harm being found at extremely small doses.

These mice are genetically identical and shared the same diet.

The mouse on the left is normal.

The mouse on the right was exposed to 1 part per billion DES while in the womb.

For years it was assumed that such low exposure would have no effect.

Until someone checked.

It seems intuitive that a high dose of a toxicant will always be more harmful than a lower dose.

And if all toxics behaved exactly the same way that might hold true.

But the effect of high doses cannot always be extrapolated to predict what happens at extremely low doses.

The effect of a 'dose' is not that simple.

Factors that must be considered include

- Magnitude
- Duration
- Rate of absorption
- Timing
- Individual metabolics
- State of health and nutrition when exposed
- Concurrent exposure to other toxicants — including order of exposures and any synergies

When very low doses cause greater effects than higher doses the situation is called 'hormesis'.

Non-monotonic dose-response (NMDR) curves graphically describe hormesis.

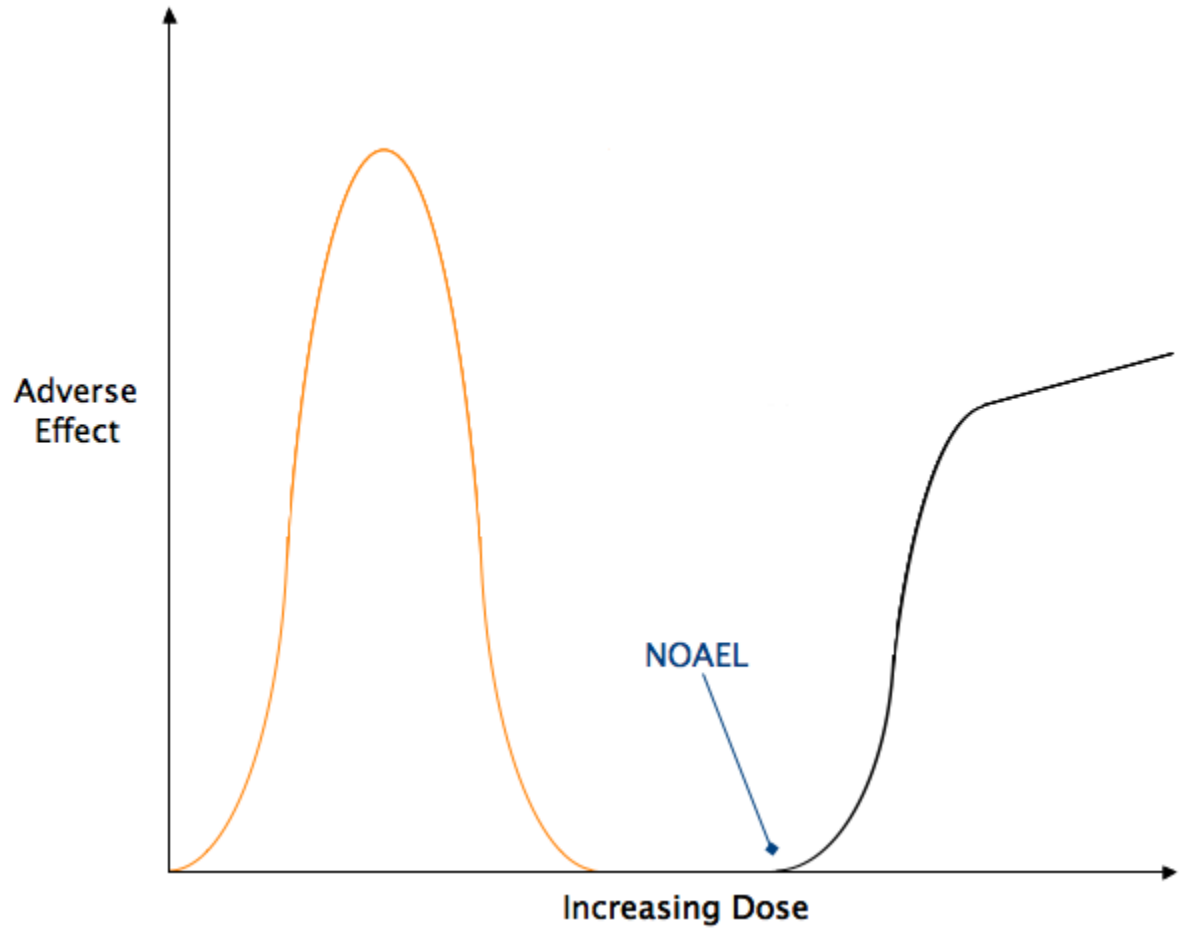
In the illustration below, the black line represents a traditional dose-response.

First, effects from a large dose are measured.

Then smaller doses are tested until no adverse effects are observed (NOAEL).

The orange line represents a dose-response discovered by testing at ultra-low doses.

The specific effect may be different but it is stronger.



This data review looked at nearly 57,000 dose-response studies representing the effects of more than 2,100 separate drugs considered for tumor treatment.

It found that the threshold model ('dose makes the poison') couldn't explain the data.

Instead, hormesis was found 4x more often than chance would predict.

The hormetic model did a superior job of interpreting low-dose toxic responses.

Exactly how can a chemical exhibit one kind of effect at very small levels and a different effect — or no effect at

all — at higher levels?

That is a reasonable question, and one that new research seeks to answer more fully.

One explanation is that

- At low levels a chemical may change the ratio of receptors stimulated
- At higher levels the receptors are completely overwhelmed.

Another explanation is that

- At low concentrations a chemical may influence cell behavior without exhibiting damage
- At higher concentrations the cells are actually damaged or destroyed

In some circumstances both explanations may be correct.

Hormones play specific roles, at specific moments in time, throughout a person's life.

Hormones help to regulate biological processes by binding to cell receptors and signaling the processes to start, stop, speed up, or slow down.

Sort of like a dimmer switch on a light.

Some chemicals resemble hormones.

These chemicals are known as endocrine disruptors.

They can mimic hormones, block them, or have other effects.

If the actions of hormones are prevented, interrupted, or increased then the effects can range from subtle to dramatic.

For example, exposure occurring at a young age can cause a subtle change in how a gene expresses itself.

This sets up a hidden, long-term progression of conditions that eventually lead to some form of cancer.

In other cases the original disruption might occur at a key moment during development in the womb.

The dramatic result might be a birth defect, mental retardation or miscarriage.

The amount of chemical necessary to cause these disruptions does not have to be large.

A vanishingly small amount is all it takes — "just enough" to alter an event.

"...even infinitesimally low levels of exposure — indeed, any level of exposure at all — may cause endocrine or reproductive abnormalities, particularly if exposure occurs during a critical developmental window.

Surprisingly, low doses may even exert more potent effects than higher doses."

Endocrine-Disrupting Chemicals Scientific Statement
The Endocrine Society, 2009

Miniscule exposure to endocrine disruptors (hormone-like synthetic chemicals) early in life can have severe effects later in adulthood.

The original exposure can continue to have detrimental effects in future generations as well.

Exposure to environmentally low levels of these endocrine disruptors may not be immediately life-threatening.

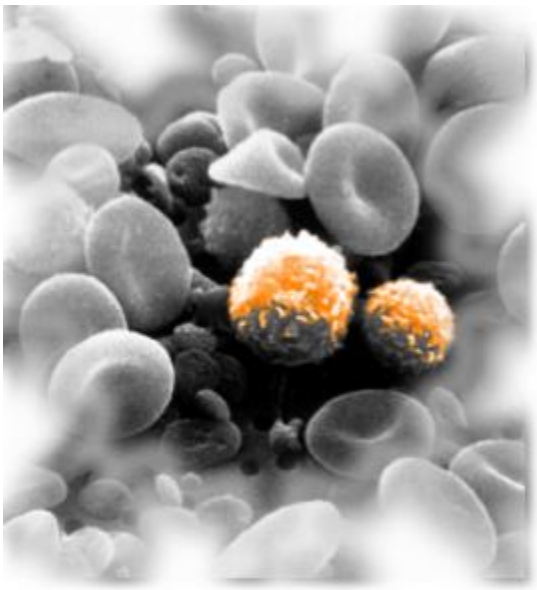
They can be just enough to alter genetic expression in a way that manifests more harmfully later in life.

A gene might be altered (mutagenesis), but the epigenome — the 'program' run by the gene — might be altered.

In the U.S., if a chemical is found to be mutagenic it has a good chance of being banned.

Currently there is no standard for regulating chemicals that cause epigenetic mutations.

The doses causing harm are so small, they can be passed from mother to daughter via placenta and breast milk for generations...



Persistent organic pollutants (POPs) linger inside the human body for decades.

These include chemicals such as

Aldrin

Chlordane

DDT

Dieldrin

Dioxins

Endrin

Furans

Heptachlor

Hexachlorobenzene

Mirex

PCBs

Toxaphene

POPs increase the risk of diabetes, cancers, birth defects, and disabilities.

It appears that these chemicals disrupt genes involved with glucose regulation.

A single POP by itself increases the likelihood of diabetes by 3x to 5x.

In combination the incidence of diabetes increases by 38x.

Here is an audio stream from Living on Earth discussing the relationship between toxics and diabetes (6 minutes 40 seconds).

Toxics have an affinity for fat.

Evidence is mounting that toxics, not calories, are the primary cause of obesity.

The body increases fat production as a way to store toxicants away from other parts of the body.

Three studies — one in the San Francisco Bay Area and two in Texas — show a correlation between airborne pollutants and the rate of autism.

For every 1000 pounds of mercury emitted from Texas smokestacks there is a 61% increase in that state's Autism rate.

See who's polluting in your neighborhood.

See maps depicting global toxic emissions in certain years.

Another set of maps for mercury can be found here.

See the EPA's latest reports on Air Quality Monitoring Information.

These four studies link 7 insecticides and 1 herbicide to breast cancer.

Six of the insecticides are banned by the EPA (lindane only recently).

Malathion is still widely used.

The herbicide 2,4-D is still used in lawn products and agriculture.

Glutathione is the body's #1 molecule for detoxification.

Coping with toxic burden spends glutathione faster than it can be replaced.

Glutathione deficiency leads to mitochondrial failure and brain damage.

Ibuprofen reduces the body's production of glutathione (here and here). Acetaminophen (Tylenol, Paracetamol) depletes it.

'The dose makes the poison' is generally regarded as simple and true.

If a dose is low enough to cause no effect, there seems no reason to test lower doses.

Chemical safety policies are based on this 600-year-old premise.

'Safe' levels of exposure are based on the lowest levels tested with no effect.

Now we realize harm can occur at much lower thresholds than previously considered possible

Toxological data typically describes the effect of a chemical when it is isolated from as many variables as possilble.

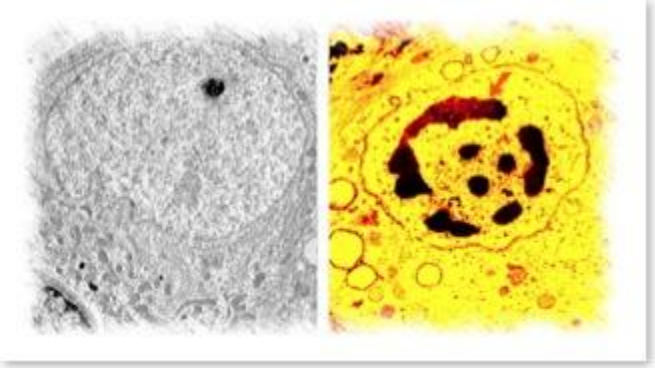
In the real world, pollutants interact in complex mixtures and conditions.

A wide range of conditions are at play, and chemicals can behave very differently when combined with other chemicals.

Harm can be amplified when chemicals are combined.

Synergistic toxicity is common.

Even the body's own natural chemicals, such as hormones, can enhance synergistic toxicity.



Heavy metals, organophosphates, and other chemicals damage cells by excitotoxic activity.

Excitotoxins are deliberately added to a wide range of foods and drugs.

Excitotoxins increase synergistic toxicity.

Genetic susceptibility plays a role in body burden.

For instance roughly 20% of the population have genetic inability to excrete heavy metals effectively.

Their toxic burden accumulates faster, their illnesses are more obvious.

They are the "canaries in a coal mine" in an environment that is increasingly toxic.

New evidence is showing that each person has an individualized genome — a unique pattern of whole DNA sections gained or lost.

Some chemicals change genes and epigenes on-the-fly.

Some of these genetic changes become permanent and are passed down in heredity.

Science Photo Library

Viruses, bacteria, yeasts, parasites, and mold aggravate body burden at any stage of life.

Research is revealing that some microorganisms interact directly with chemicals to

boost infection.

The Centers for Disease Control (CDC) is running the National Biomonitoring Program (NBP) started in 1998.

Every two years the NBP attempts to assess exposure to environmental chemicals in the general U.S. population.

The more chemicals they look for, the more they find.

Data shows people typically carry at least half of the 200+ toxic chemicals monitored.

Chemicals have been detected in the placenta, umbilical cord blood, bloodstream, and body fat of infants as well as in the human breast milk they drink.

This study found babies averaging over 200 industrial chemicals and pollutants in their umbilical cord blood, with 287 chemicals total.

A follow up study found 232 toxic chemicals in 10 minority babies.

<iframe width="480" height="360" src="https://www.youtube.com/embed/0-kc3AIM_LU" title="YouTube video player" frameborder="0" allow="accelerometer; autoplay; clipboard-write; encrypted-media; gyroscope; picture-in-picture" allowfullscreen></iframe>
EWG's "Ten Americans" presentation

This study in Maine found adults had measurable levels of 36 toxic chemicals in their bodies including

- Phthalates from cosmetics and vinyl plastic
- Brominated flame retardants (PBDEs) from televisions and furniture,
- Perfluorinated chemicals from stain-resistant and non-stick coatings
- Bisphenol-A from reusable water bottles and baby bottles
- Toxic metals such as lead, mercury and arsenic

In 2007, California launched the nation's first statewide biomonitoring program.

The first report is currently due by July 1, 2012, with new reports to follow every two years.

The spectrum of both 'rare' and 'common' illnesses is on the rise.

The connection with body burden is growing clearer.

The NIH defines a rare disease as one affecting 200,000 or fewer Americans.

25 to 30 million Americans suffer from one of the nearly 6,800 identified rare diseases.

That rivals the 40 million Americans with one or more of the three "major" diseases: heart disease, cancer or diabetes.

Developing fetuses and infants are the most vulnerable.

The cost is colossal.

Toxics that were banned decades ago persist in the soil, air and water.

They can still pass through the skin, nostrils or mucus membranes and into the bloodstream and body tissue.

In this Washington state study, ALL participants had detectable levels of PCBs, while 8 out of 10 had DDT in their blood.

The problem will multiply without a new course of action.

For example, the Kid-Safe Chemicals Act (KSCA) seeks to overhaul the Toxic Substances Control Act (TSCA).

This legislation requires chemicals to be proven safe before entering the market or to remain in commerce.

Each person's body burden is likely to fluctuate over the course of hours, months, and years depending on their particular exposures and metabolism.

The science of body burden is complex and still in early stages.

Arsenic is a classic example of 'dose makes the poison' toxicology.

Give someone enough and they become poisoned. Below that, no problem.

But research shows arsenic disrupts many different hormone receptors at levels of just a few parts per billion —

levels found in drinking water.

Chronic (low level) intake of arsenic has been associated with increased risk of cancer, diabetes, developmental and reproductive problems, and cardiovascular disease.

Recognizing arsenic's hormetic pattern helps make sense of that research — all of those illnesses can be triggered or exacerbated by hormone disruption.

Here is a link to ~30 studies describing other accounts of toxic hormesis.

If a chemical is regulated, its safety threshold was probably based on finding a level of exposure that causes no harm — the 'no observable adverse effects level' (NOAEL).

But a NOAEL is derived by starting with a high dose and then reducing subsequent doses until no affect is observed.

That approach misses other harm that can take place at even lower doses.

The emergence of hormesis poses a large problem for how agencies like the EPA and FDA do their job.

It also increases the level of risk companies must manage in the production and utilization of chemicals.

Toxics that don't have a NOAEL can still exhibit nonlinear effects at low doses.

Lead (Pb) is an example.

It is well documented that there is no safe level of Pb exposure, but it is generally presumed that the harm diminishes as exposure decreases.

This research finds that Pb-associated decrements in IQ are proportionately greater at a blood lead level below 10 µg/dL than above.

So even though harm continues to climb at higher levels of exposure, the effect is most pronounced at levels below the CDC definition of "elevated lead".

The science of hormesis is relatively new.

One place to learn more is Our Stolen Future.

This PubMed search provides a current survey of articles related to hormesis, NMDR, and toxicants.

There is still more investigation to be done, but it looks like chemicals that are endocrine disruptors at one level are often excitotoxic at another level.

Some people are under the misconception that hormetic effects are always beneficial.

In rare instances, the ultra-low dose effect of a toxicant may exert beneficial influence in narrowly defined situations (possibly, for example, radiation hormesis).

But so far, the bulk of hormetic rresearch reveals new points of harm.

Hormesis is not a case where the toxicant exerts one effect at high doses (harmful) and the opposite effect at low doses (beneficial).

Hormesis is a case where the toxicant exerts particular effects at higher doses (harmful) and different effects at lower doses (also harmful).

Beware of attempts to manipulate hormetic data so that toxic regulations become relaxed...

Hormesis does not suggest that "a little poison is good for you".

Hormesis shows how a toxicant is harmful across a greater range of doses.

Investigating toxicants at low levels is important research, and hormetic modeling is a valuable contribution towards improving global health and safety.

Unfortunately there are tens of thousands of chemicals suspected to be toxic — but for which no studies have been done of any kind.

No idea how they affect the brain, or developing fetuses, or how they interact with other toxics.

Nothing.

But they are showing up in our bodies.

EWG's "Ten Americans" presentation

There are ~3000 chemicals produced in volumes exceeding 1 million pounds per year.

Yet only about a dozen have been investigated for their effects on the developing brain.

A developing brain is vulnerable to permanent impairment.

Currently 1 in 6 children have some kind of neurodevelopmental disability.

The fetal brain grows into a complex organ consisting of billions of precisely located, highly interconnected and specialized cells.

This growth occurs within a tightly controlled time frame.

Each developmental stage has to be reached on schedule and in the correct sequence.

Interference by toxics at any stage can have permanent consequences.

This article by Environmental Health Perspectives provides a helpful introduction into neurodevelopment and what can cause it to go wrong.

A cancer's origin can be rooted in toxicants passed on by a parent, or even a grandparent.

This video is remarkable.

It is an episode of the Phil Donahue show with special guest Dr. Doris Rapp.

The year was 1989.

It demonstrates very clearly the connection between environmental triggers and abnormal behavior.

The show looks at children and adults.

sailhome

Chemicals that didn't exist a few generations ago are inside each of us right now

Toxic Body Burden

Illnesses — including remarkable combinations of symptoms — are on the rise.

So are the numbers of chemicals getting mixed inside us.

Is there a connection?

Yes

All babies are now born pre-polluted.

Starting before birth, children are exposed to chemicals that impair normal growth and development.

Exposures continue throughout life.

Chemicals accumulate, interact within the body, cause illness.

And get passed on from parent to child for generations.

Daughter's age when she has excreted 99% of a pollutant aquired from her mother

The sources for body burden are everywhere — industry, foods, and many that are not obvious.

To learn more see http://www.sailhome.org or locally VisuAlchemy.gallery/r2

- Toxic Body Burden
- Hormesis

- Excitotoxins
- Aspartame
- MSG
- Hydrolysis
- Diseases
- Excitotoxic Ingredients

- Common Burdens
- Bisphenol-A
- Fluoride
- Vikane
- Heavy Metals
- Mercury
- Organophosphate
- PBDE
- PCB
- Perchlorate
- PFC
- Pthalate

- Industrial Sources

- Food Sources

- Other Sources
- Fragrance
- Perfumes
- Fipronil
- Natural Defense
- Corn Syrup
- Hexane
- Triclosan
- Sucralose
- Soft Drinks
- Better Living

- Synergistic Toxicity
- Risperidone and Methylphenidate

- The Cost

- Vaccines
- MAC
- Flu Myths
- FluMist Effects
- DTaP and Polysorbate 80
- HepB and Phosphate
- Thimerosal

- Calculator
- MMR and Autism

- Solutions

- Products
- Capsule Blanks
- Ceramic not Teflon

Recovery (work in progress)

- Say What?...
- Alkalized H2O
- Cast Iron
- Piano
- Stainless Steel

▸ Environmental Working Group (EWG)

▸ Our Stolen Future

▸ Environmental Defense Canada

Listen to the October 19, 2006 public radio broadcast of KQED's Health Dialogues.

061019KQED, 53 minutes, 12 MB mp3

It covers Prop 65, body burden, and biomonitoring.

Or simply search phrases like chemical body burden and human biomonitoring