Is Glyphosate that bad?

What is known and not known about the toxicity of this herbicide

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U.S. LEGAL NEWS MAY 13, 2019 / 4:21 PM / 5 MONTHS AGO

California jury hits Bayer with $2 billion award in Roundup cancer trial

Tina Bellon

6 MIN READ

(Reuters) - A California jury on Monday awarded more than $2 billion to a couple who claimed Bayer AG's glyphosate-based Roundup weed killer caused their cancer, in the largest U.S. jury verdict to date against the company in litigation over the chemical.

EPA disagree's with conclusions……

This is a challenging topic

- I will be using lots of technical terms/examples
  - Resources exist that explain these in more detail
- I will try to base comments on facts and limit my opinions
  - I have gotten my information from these sources
    - National pesticide information center (http://npic.orst.edu/)
    - Environmental Protection Agency
- If you have other facts you would like to share with the group, I will provide time at the end of my presentation
  - I will ask the source of this information

Outline for presentation

- Overview glyphosate properties
  - how it works in plants
  - How it works in animals
- Discuss basic principles of toxicity
- Talk about cancer and glyphosate
  - Why different people have different opinions
- Compare glyphosate toxicity to other known carcinogens

Lots of information is available that creates strong opinions

not all are based on facts….

Cancer rates are soaring in the USA

- According to the American Cancer Society "Overall, cancer incidence and mortality declined among men; and, although cancer incidence was stable among women, mortality declined."

- Cancer rates in some countries are increasing
  - The main factor is **because we live longer (UK study)**

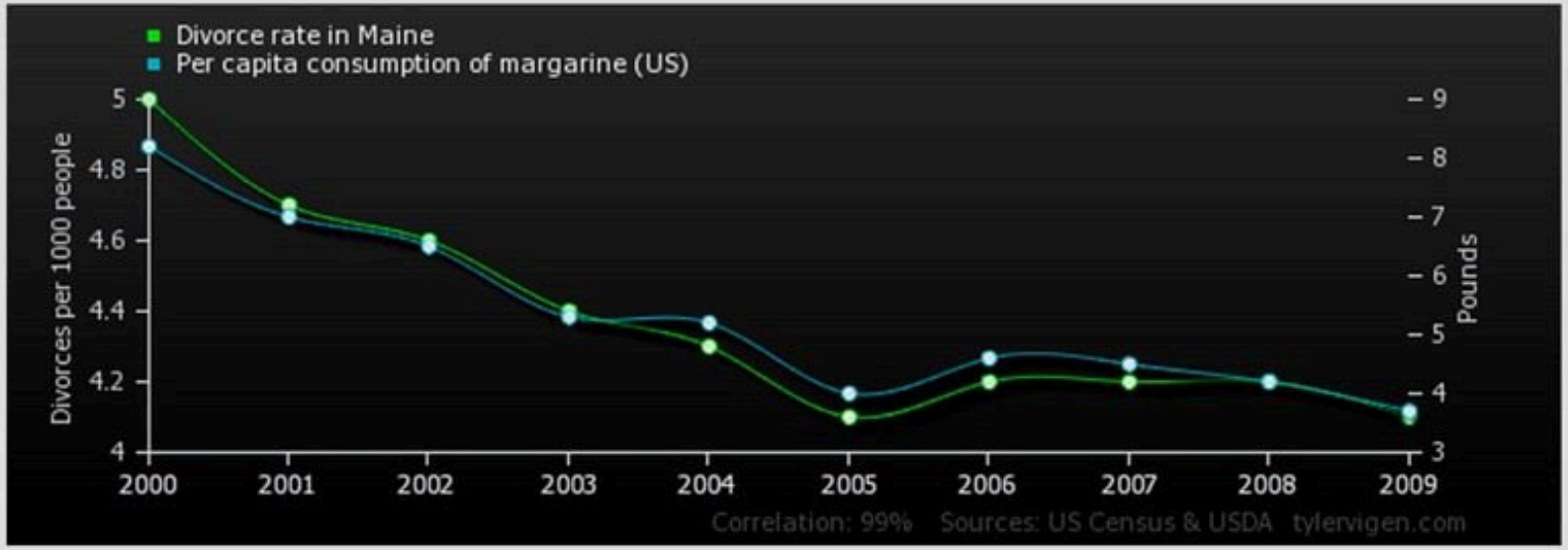
Be cautious of correlation figures like these

http://tylervigen.com/spurious-correlations

Divorce rate in Maine

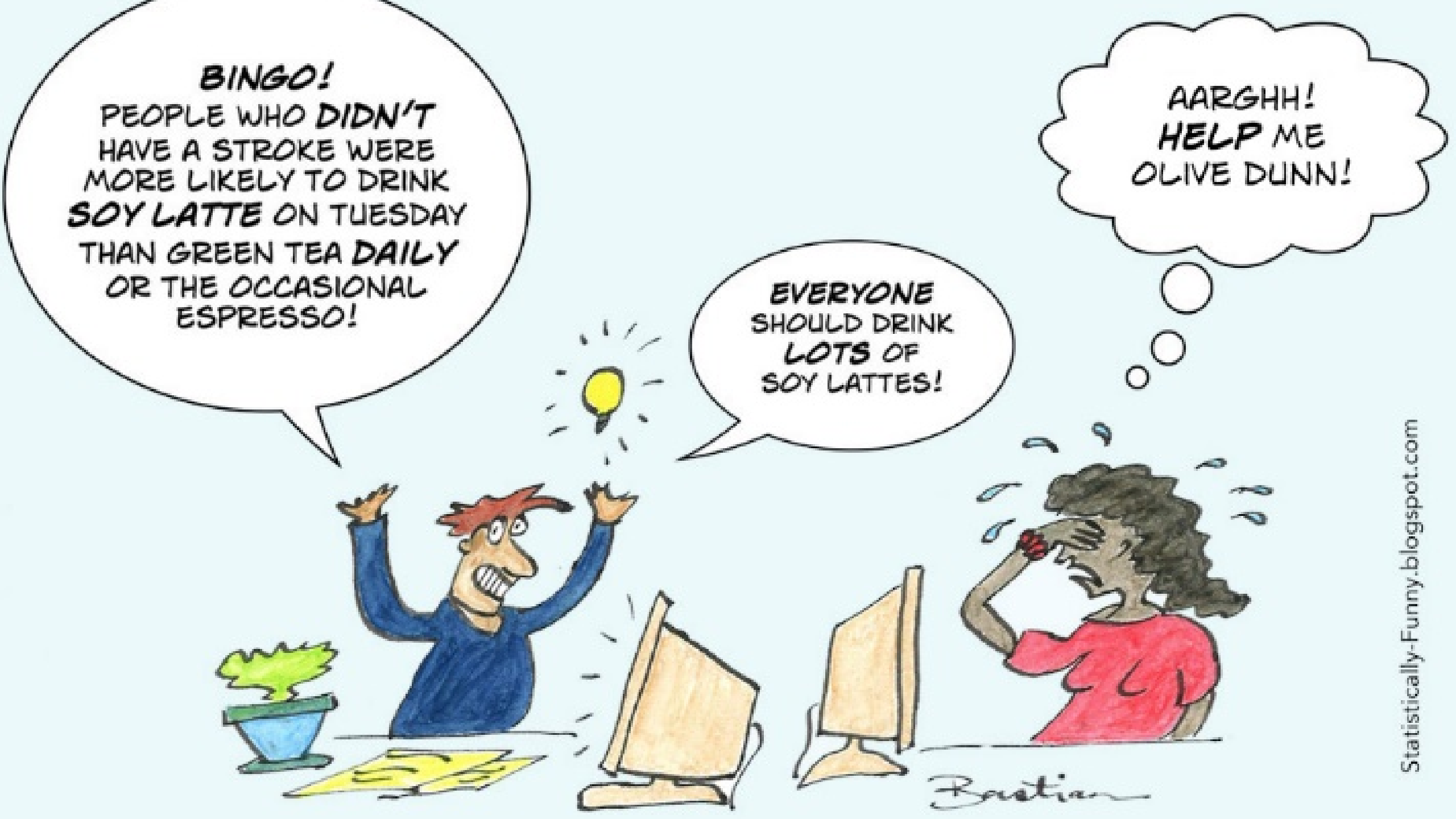
correlates with

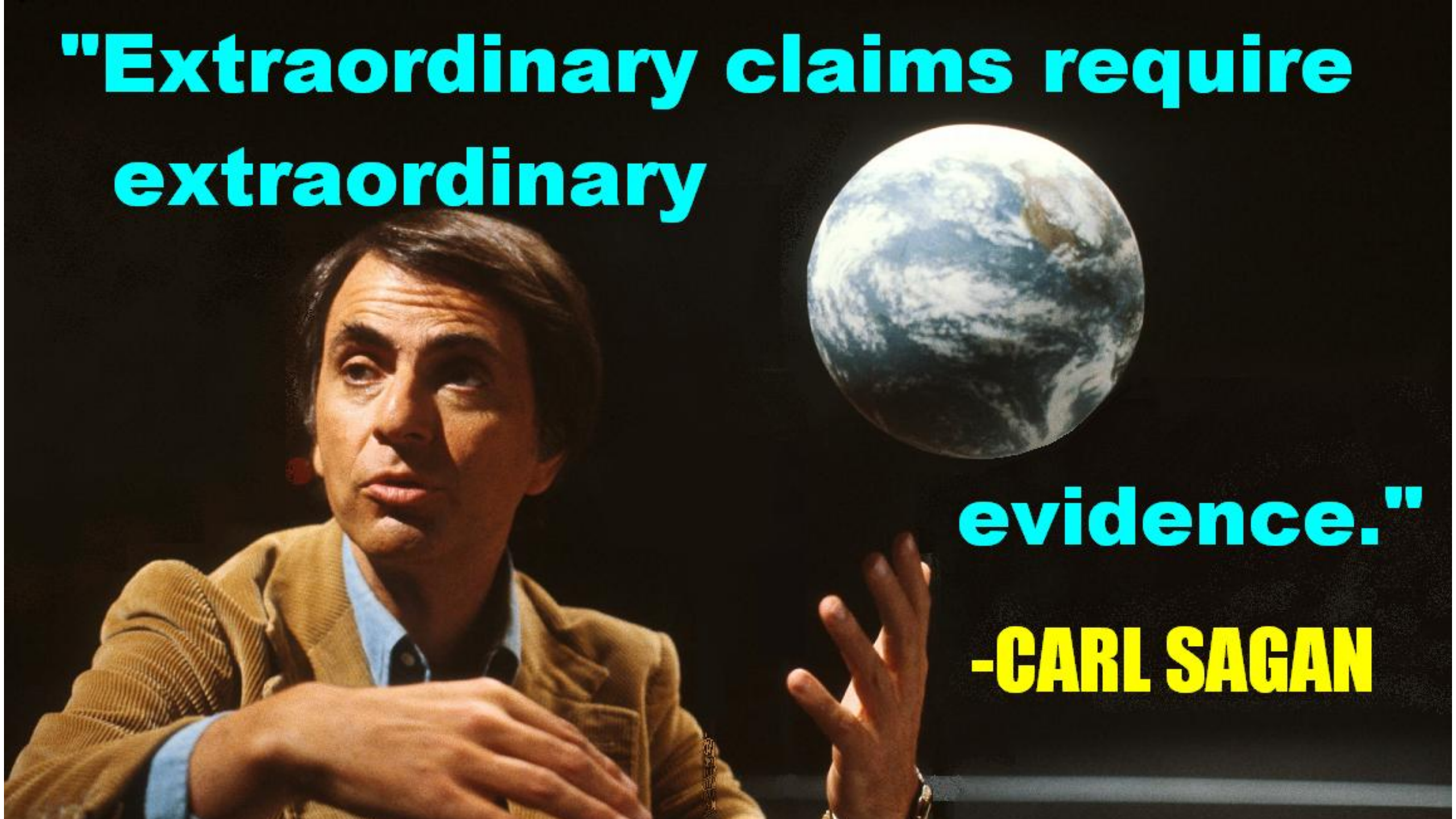
Per capita consumption of margarine (US)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Divorce rate in Maine *Divorces per 1000 people (US Census)*	5	4.7	4.6	4.4	4.3	4.1	4.2	4.2	4.2	4.1
Per capita consumption of margarine (US) *Pounds (USDA)*	8.2	7	6.5	5.3	5.2	4	4.6	4.5	4.2	3.7

Correlation: 0.992558


BINGO!
PEOPLE WHO DIDN'T HAVE A STROKE WERE MORE LIKELY TO DRINK SOY LATTE ON TUESDAY THAN GREEN TEA DAILY OR THE OCCASIONAL ESPRESSO!
EVERYONE SHOULD DRINK LOTS OF SOY LATTES!
AARGHH! HELP ME OLIVE DUNN!
Statistically-Funny.blogspot.com


"Extraordinary claims require extraordinary evidence."
-CARL SAGAN

Disclosures before I begin talking about glyphosate

- I am a weed scientist, not a toxicologist
- I have been funded in the past by Monsanto
  - Evaluating effects of glyphosate, acetochlor on establishing and established alfalfa last 10 years
- Like others I have opinions about this topic.
- My goal is to demonstrate what is known and not known and what data exists on the toxicity….
  - Science-based information….

Who is a better quarterback?

What is Glyphosate?

- Herbicide discovered in 1950s, used since 1970's
  - Active ingredient in many herbicides (Roundup)
- Most widely used pesticide in United States
  - >250 millions lbs applied annually
  - Agriculture accounts for 90% use
  - Non-Agriculture accounts for 10%use

How it kills/damages plants

- Disrupts the shikimate acid pathway that leads to the production of aromatic amino acids

- As a result protein development ceases and **plants stop growing** and eventually it dies

Roundup Ready alfalfa

How it kills/damages animals

- Different pathway as animals don't have the shikimate acid pathway
  - Only plants and some micoorganisms

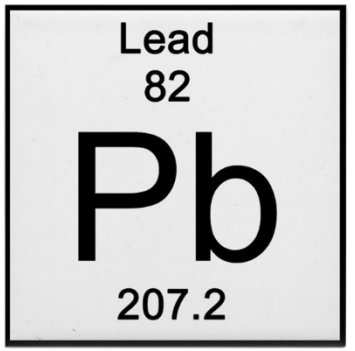
- **Unknown**
  - Implicated to be an endocrine disruptor
  - Surfactant in some formulations may be cause of higher toxicity **in animals**.
    - polyoxyethyleneamine or polyethoxylated tallow amine (POEA)

Let’s talk about toxicology

- Merriam –Webster defines toxicity as:

the quality, state, or relative degree of being poisonous

- Two types:
  - Acute = immediate response after one exposure
  - Chronic = long-term repeated exposure
- Toxicity can vary based on many factors
  - potency of the chemical
  - length and type of exposure
  - type of population
  - individuals (allergic reaction)



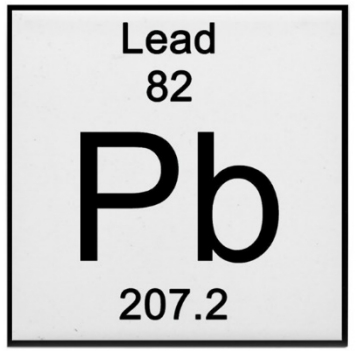
Let's compare the potency of two compounds

Cyanide

- 1.5 mg/kg ingested is typically lethal

Lead

- 450 mg/kg ingested is typically lethal



Exposure method also matters

Cyanide

- 1.5 mg/kg ingested is typically lethal
- **Much more lethal when inhaled vs ingested**, not very lethal when on skin

Lead

- 450 mg/kg ingested is typically lethal
- Ingestion most common, but **inhalation most lethal**. Not common for dermal exposure to be lethal.

Example most of us can relate to

- Alcohol ingestion during happy hour

- I drink TWO 12 oz beers (5%) in two hours
  - My blood alcohol level is 0.03%

- I drink **Four** 12 oz beers (5%) in two hours
  - My blood alcohol level will be higher = 0.09%

The dose makes the poison

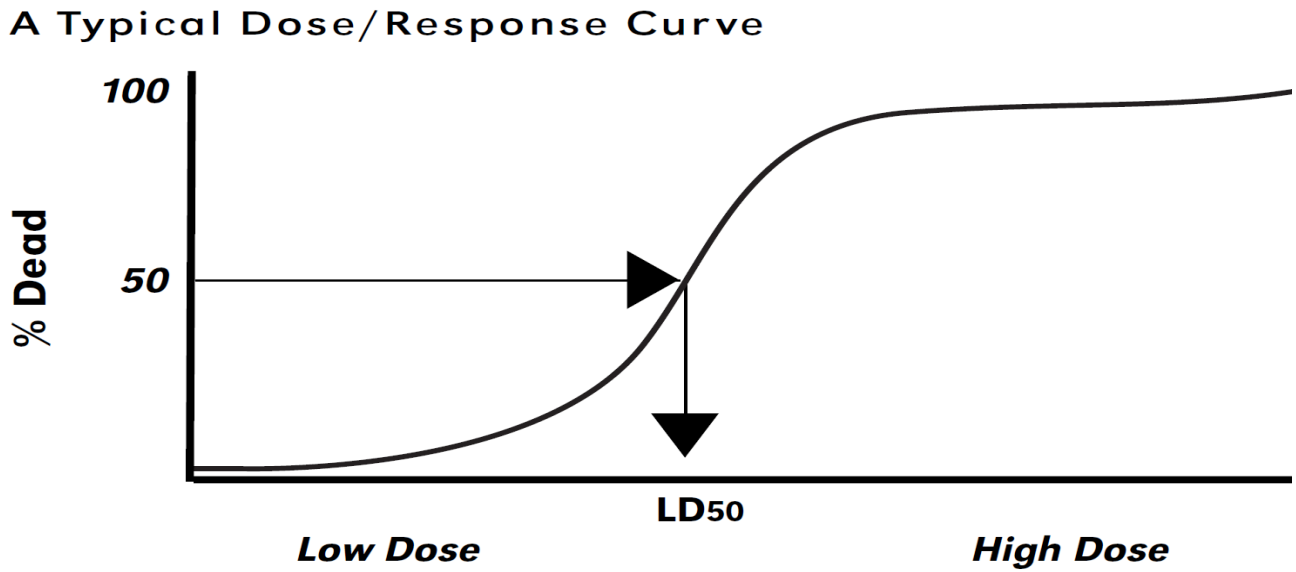
Warfarin is a great example

- BLOOD THINNER:
  - 0.5-10 mg common
  - I weigh 77 kg
    - 10 mg = dose would = **0.13 mg/kg daily**

- RODENT POISON
- we use baits where the goal is for rodents to eat **>50 mg/kg daily**

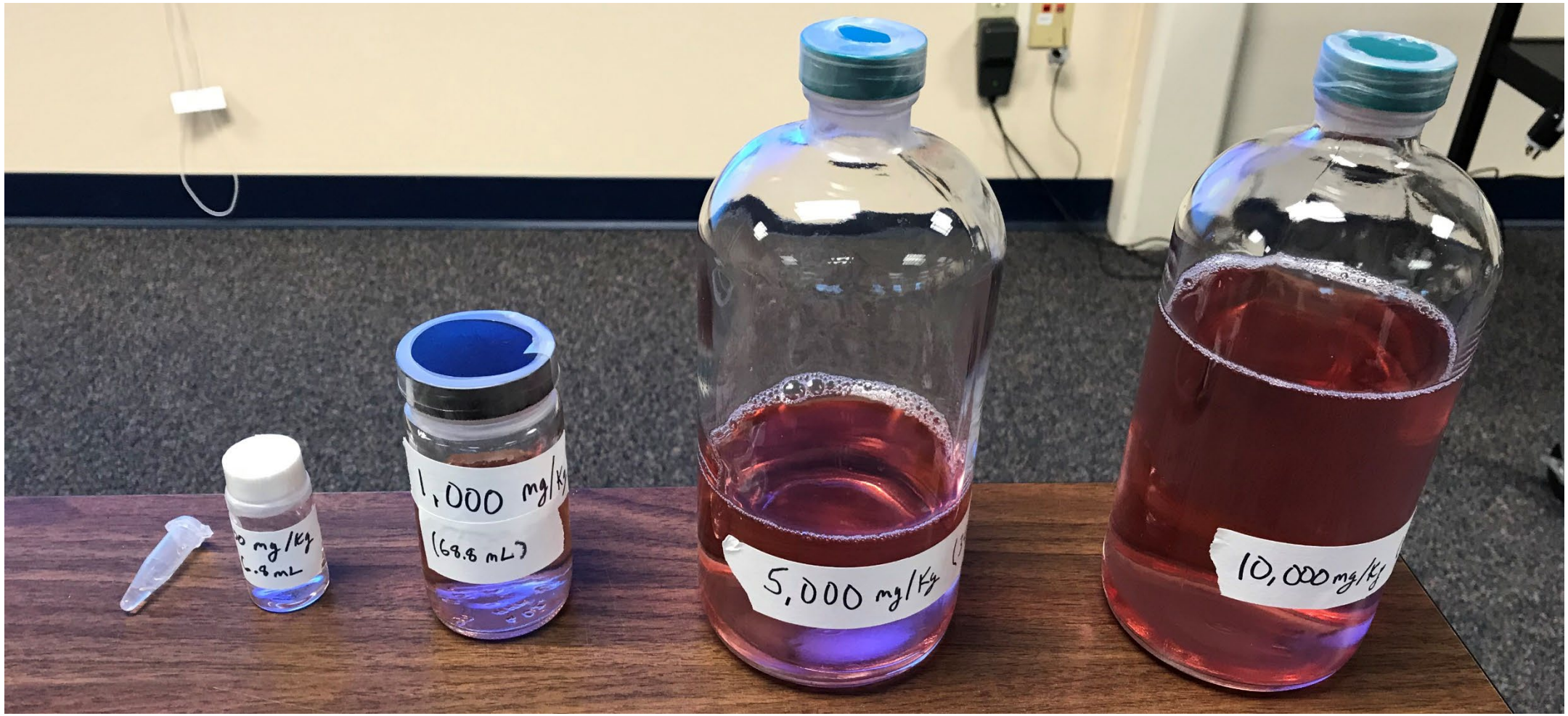
Term we use to discuss toxicity of a compound

- Since individuals can respond differently to compounds we evaluate response over a group of individuals
  - Acute toxicity: Lethal dose that kills 50% individuals = LD50



- Sensitivity to compounds is sensitive to weight of individual
  - mg compound per kg individual body weight = mg / kg

Represents the mg/kg of glyphosate from Roundup weathermax for a 150 lbs individual



10 100 1,000 5,000 10,000

What is the acute toxicity of glyphosate to animals?

Acute toxicity is considered very low for glyphosate

- Oral LD50 (caffeine LD50 for rats **368 mg/kg**)
  - in rats is > 4,320 mg/kg, in mice >than 10,000 mg/kg and in goats > 3,530 mg/kg
  - in three formulated products ranged from 3,860 to > 5,000 mg/kg in rats.
- Dermal LD50 (caffeine LD50 for rats **>2,000 mg/kg**)
  - in rabbits is > 2,000 mg/kg.
- Inhalation LC50 (caffeine LD50 for rats **4.94mg/l**)
  - In rats > 4.43 mg/L based on a 4-hour, nose-only inhalation study.21
  - for two formulated products in rats >1.3 mg/L and 3.2 mg/L in rats

What is the acute toxicity of glyphosate to humans?

Acute toxicity is considered very low for glyphosate

- Oral
  - Review of 80 intentional ingestion cases
    - Seven cases resulted in death (9%)
- Dermal
  - Roundup®, containing 41% glyphosate, was applied to the skin of 204 male and female volunteers. No sensitization was observed.
- Inhalation
  - Inhalation may cause oral/nasal discomfort, throat irritation

What is the chronic toxicity of glyphosate?

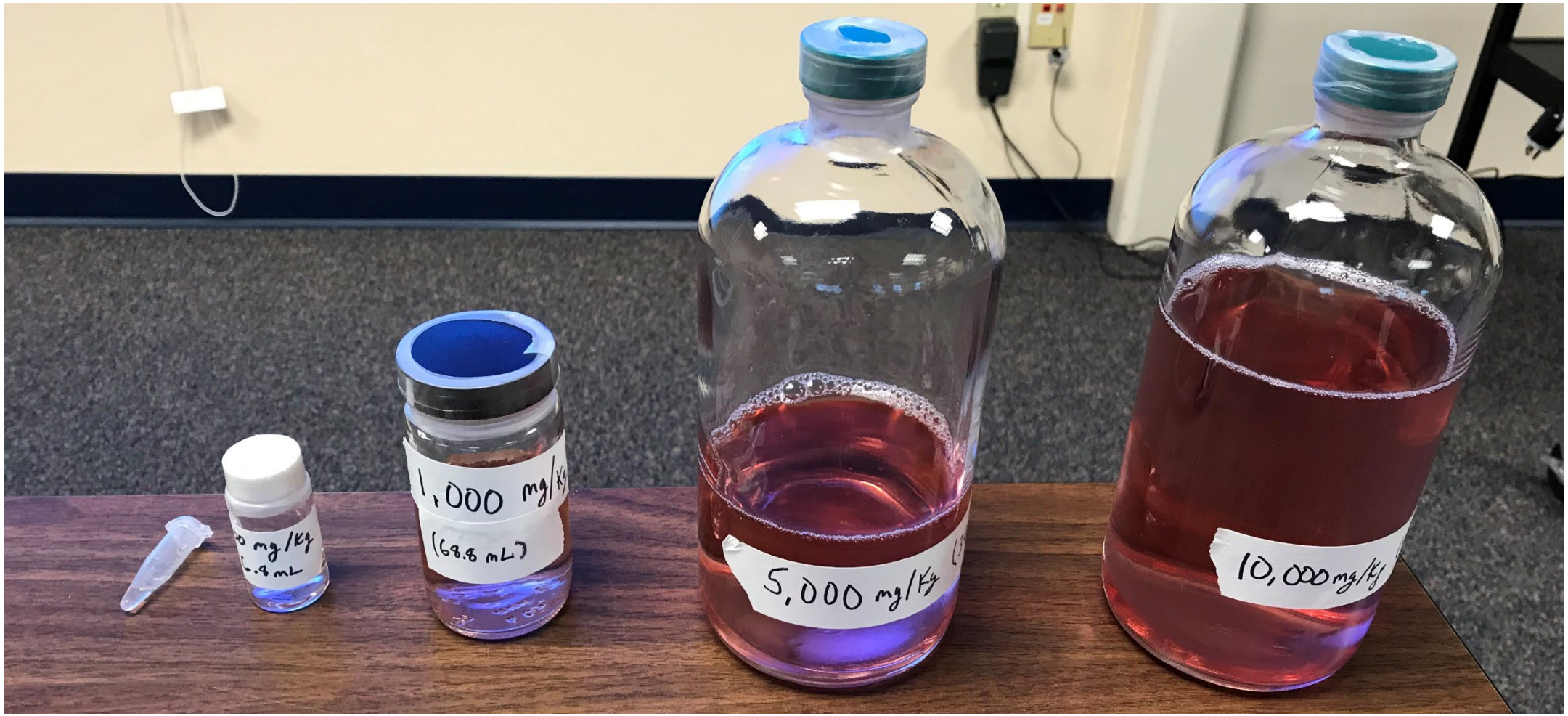
animals

- Dogs were fed 0, 20, 100, or 500 mg/kg/**day** of glyphosate **for one year**.
  - No effects were observed.

- Male rats were fed glyphosate at 89, 362, or 940 mg/kg/**day** and females were similarly fed at concentrations of 113, 457, or 1183 mg/kg/**day** **for 2 years**.
  - high-dose females had decreased body weight gain.
  - high-dose makes had decreased urinary pH, increased evidence of cataracts and lens abnormalities, and increased liver weight.
  - No effects were observed in the low-dose and mid-dose groups.

- Rats were fed glyphosate at doses of 0, 100, 300, or 1000 mg/kg/day **for two years**.
  - RESULTS: After 52 weeks, some rats in the two highest dose groups had enlarged salivary glands with cellular changes.

Represents the mg/kg of glyphosate from Roundup weathermax for a 150 lbs individual



10 100 1,000 5,000 10,000

What is the chronic toxicity of glyphosate to humans?

- Collected urine samples over 8 months from workers at two forestry nurseries where glyphosate was used for weed control.
  - RESULTS: No glyphosate was detected in any of the 355 urine samples.

- Five forestry workers sprayed glyphosate for 6 hours a day over the course of a week.
  - RESULTS: No differences were found in medical examinations and laboratory testing performed on the workers following pesticide application.

- Collected urine samples from farm families in South Carolina and Minnesota
  - RESULTS:
  - On the day of application, 60% of farmers had a detectable level of glyphosate in their urine of at least 1 ppb. (average was 3 ppb with a maximum of 233 ppb)
  - Mean urinary concentrations of glyphosate were higher in farmers who did not use rubber gloves.

What about cancer?

- **In 2015:** Implicated as potential to cause cancer by IARC (International Agency of Research on Cancer).
  - Specialized cancer agency of the World Health Organization
  - No regulatory function
- Determined to not likely be carcinogenic/cause risk to humans by
  - Environmental Protection Agency (2017)
  - European Food Safety Authority (2015)
  - Joint FAO/WHO Meeting on Pesticide Residues (2016)
    - FAO = United Nations Food and Agriculture organization
    - WHO = World Health Organization

Why the differences in conclusions?

- Different people summarizing the information with different processes
  - IARC: Invited experts
  - EPA/European Union: In house scientists

- Different approaches
  - IARC evaluates if a compound is carcinogenic **without considering use patterns**
  - Regulatory groups **include use patterns**

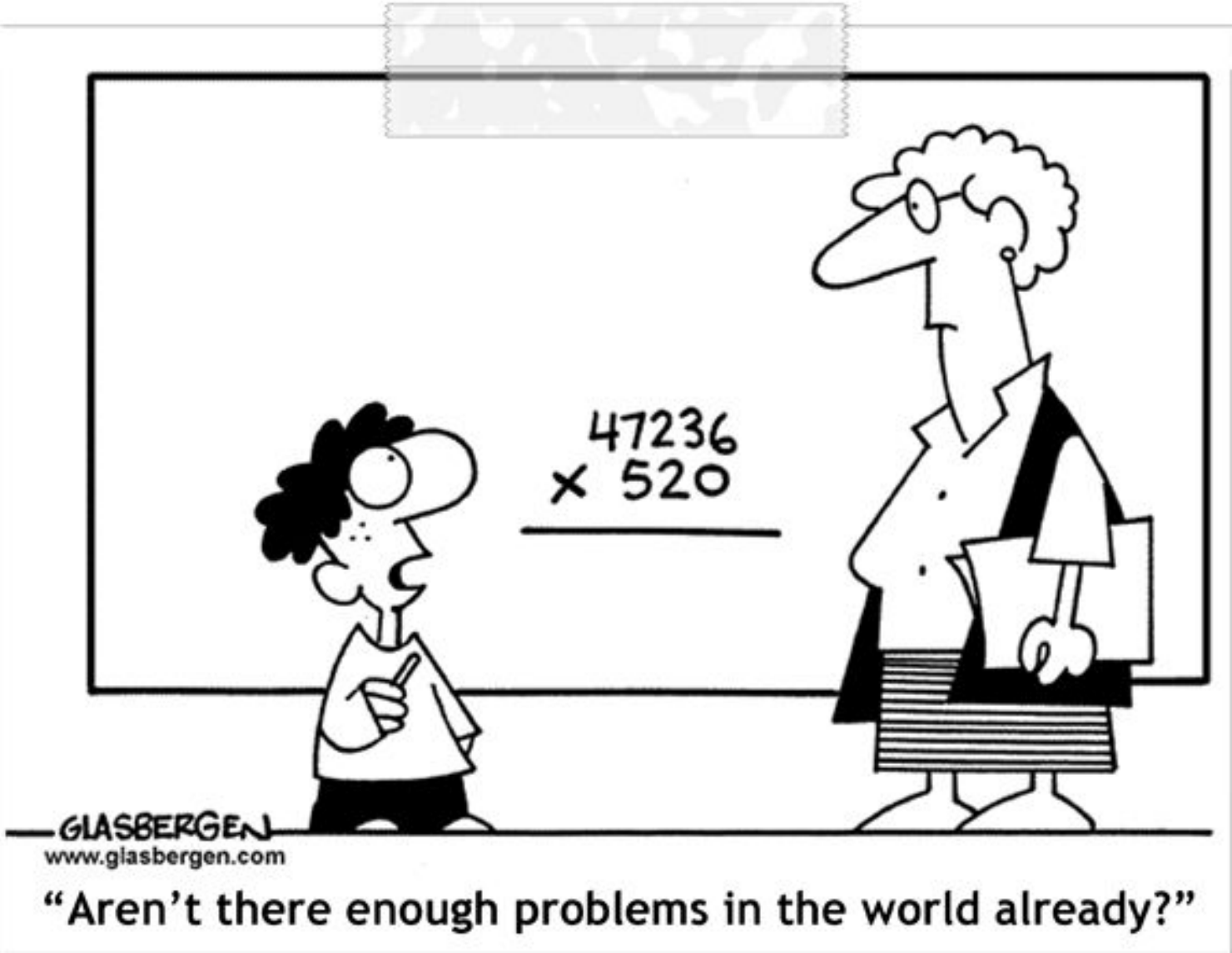
EPA recently released an updated Review of glyphosate (December 2017)

- "Reevaluated the human carcinogenic potential of glyphosate, which included a weight-of-evidence evaluation of data from animal toxicity, genotoxicity, and epidemiological studies……. **The Agency concluded that glyphosate should be classified as "not likely to be carcinogenic to humans."**

  - Some of the studies IARC used were deemed of low quality by EPA and not used
    - reported effects due to *total pesticide exposure and/or assumed glyphosate exposure* without collecting glyphosate-specific exposure information.

So groups disagree on the result…..

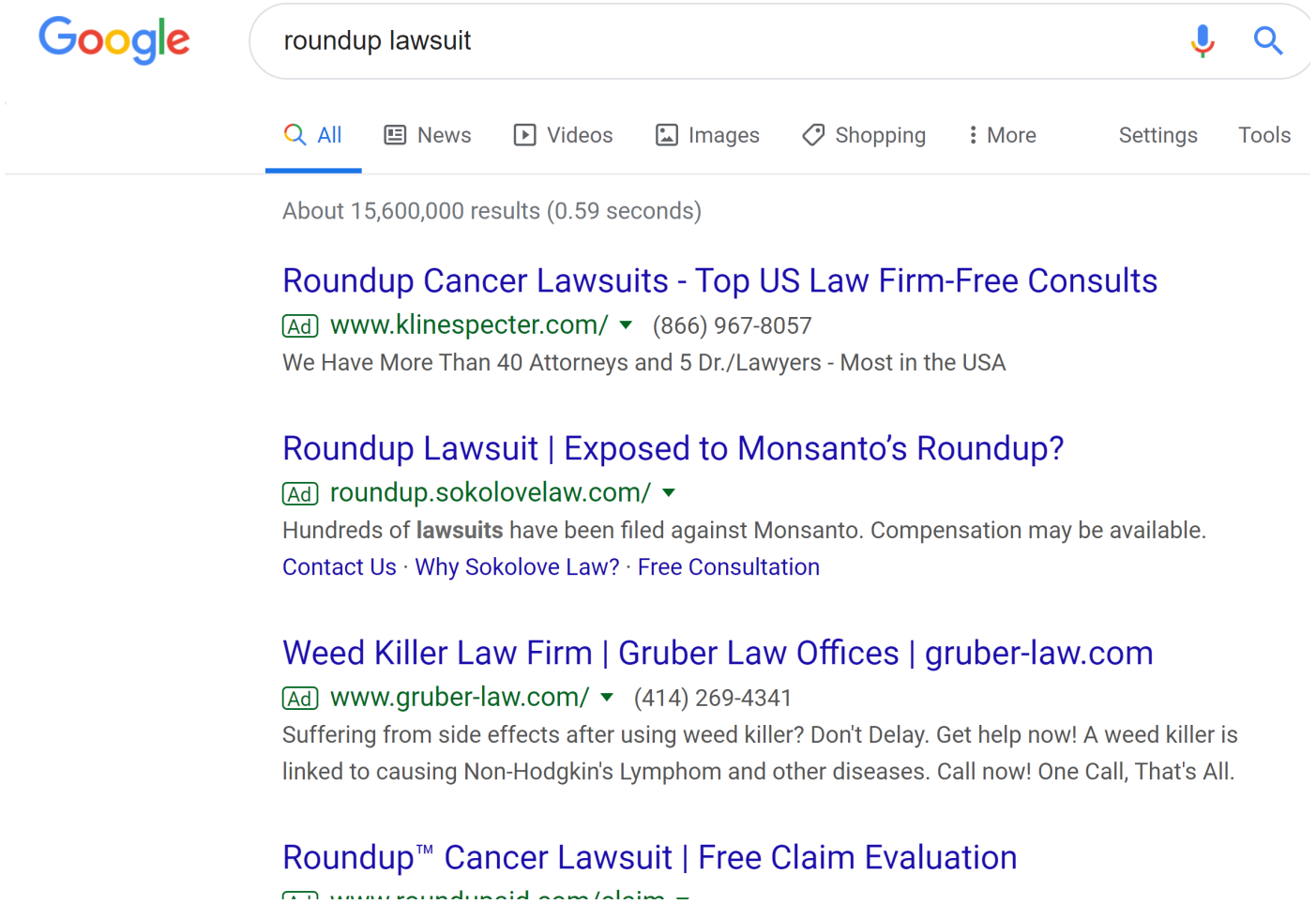
- How are you supposed to interpret this information??????
- Many groups have agendas…
  - Industry
  - Not for profit
  - Even some scientists….



- **US District Court awarded individual $289 Million for damages in relation to glyphosate/roundup**
  - The decision was made by a jury NOT SCIENTISTS
  - The core issues of the case were
    - Does glyphosate causes cancer?
    - Did Monsanto not disclose this added risk to clientele?
    - Did glyphosate exposure cause the plaintiff's cancer?

Other court cases

- 2 decisions in California
  - Both in favor of plaintiffs
- One court case in Missouri to start October 2019
- Over 14,000 cases pending
  - Many plantiffs are being sought



What was the exposure level of plaintiffs?

- First California case:
  - Used 20-30 times per year for multiple years (2-3 hours a day).
  - two accidents in which he was “soaked” with solution
  - He said he had no access to a shower until much later in the day.

- Second California case:
  - went through a gallon of Roundup per week over 30 years.
  - They did not use protective clothing.

Think about your risk

- Risk = toxicity of substance x level of exposure

- High risk people:
  - use glyphosate products on a regular bases
  - Mix the concentrated solution
  - Do not wear protective clothing/equipment

Let’s assume that glyphosate is cancer causing/carcinogen. What else is listed?

- IARC LIST of of products **known to be carcinogens**
  - 112 compounds
  - Includes:
    - Alcoholic beverages (ethanol)
    - Diesel engine exhaust
    - **Consumption of processed meats**
    - Solar radiation
    - Tobacco (smoke, first or second hand)
    - Wood dust
- Glyphosate is listed as “probably carcinogenic”

Reality check on carcinogens

American Cancer Society

What causes cancer?

- Lifestyle factors
  - nutrition, tobacco use, physical activity
- Naturally occurring exposures
  - ultraviolet light, radon gas, infectious agents, etc.
- Medical treatments
  - radiation and medicines including chemotherapy, hormone drugs
- Workplace/Household exposures
- Pollution

carcinogens don’t have equal risk

Processed meats

Tobacco

Details of processed meat as carcinogens

- The amount ingested matters
  - 50 g/day (0.1 lbs) = 1 hot dog per day will increase your risk by 17%
- Putting the risk into perspective: (American cancer Society)
  - lifetime risk colon cancer is 5%.
  - If eat more than 50g/day processed meat would raise lifetime risk to 6%.
- Size of risk is different for each compound
  - 34,000 deaths per year to high processed meat intake
  - 1 million deaths per year attributable to tobacco smoke.

Be critical of things your read from the press

Details of the research

ELSEVIER

Mutation Research/Reviews in Mutation Research

Available online 10 February 2019

In Press, Accepted Manuscript

Review

Exposure to Glyphosate-Based Herbicides and Risk for Non-Hodgkin Lymphoma: A Meta-Analysis and Supporting Evidence

Luoping Zhang [a], Iemaan Rana [a], Rachel M. Shaffer [b], Emanuela Taioli [c], Lianne Sheppard [b, d]

Show more

https://doi.org/10.1016/j.mrrev.2019.02.001

- investigated if link between **high cumulative exposures** to glyphosate and cancer
  - Same dataset that found no link but excluded subjects with lower exposure
  - High exposure was due to not wearing PPE (e.g. gloves)

- suggests a compelling link between exposures to glyphosate and increased risk of cancer

When you read the paper you see this quote

9. Conclusions and Future Directions

The rise of glyphosate as the most widely used herbicide raises serious health concerns, given its potential links with NHL. Using our high-exposure *a priori* hypothesis and including the recently updated AHS cohort in a meta-analysis for the first time, we report that GBH exposure is associated with increased risk of NHL in humans. Our findings are consistent with results reported from prior meta-analyses but show higher risk for NHL because of our focus on the highest exposure groups. However, given the heterogeneity between the studies included, the numerical risk estimates should be interpreted with caution. Additionally, as noted above and depicted in Figure 3, the

Is this interpreting with caution?

I suggest evaluating the risk and minimizing exposure

Australian guidelines

- **Slip** on some sun-protective clothing
- **Slop** on broad spectrum, water resistant SPF30 (or higher) sunscreen.
- **Slap on a hat** - to protect your face, head, neck and ears.
- **Seek** shade.
- **Slide** on some sunglasses

Where can I find information about pesticides

- Simple info for public consumption
  - National pesticide information center (http://npic.orst.edu/)

- Environmental Protection Agency https://www.epa.gov/
  - Good info on overview of risk assessment of pesticides in the US
  - Information on what data is collected and access to collected info
    - Search: Test Guidelines for Pesticides and Toxic Substances
    - Search by active ingredient
      - Look at re-registration material
- Federal Registry https://www.federalregister.gov/
  - Search by active ingredient

Realize that much of the toxicity information is created by companies attempting to register the products

- Takes > $300 million dollars to register
  - Makes registrants
    - Conduct studies and submit data to support registration
    - pay money to receive a label (annually)

- EPA closely monitors results to ensure accuracy
  - Some people question the accuracy of data….

In Summary

- Glyphosate is a herbicide that has low **acute** human toxicology
- Debated if glyphosate can cause cancer among experts
- Current research suggests it is much less potent that other items we voluntarily ingest …
  - Processed meat, alcohol

In Summary

- Several **CIVIL** court cases have awarded $$$ to plaintiffs
  - Many more are scheduled in the future

- If using glyphosate or other pesticide products
  - Evaluate the risk of using the product prior to use
  - Follow directions on label to minimize exposure
    - Gloves, pants, socks, shoes, long-sleeve
  - If exposed take immediate action

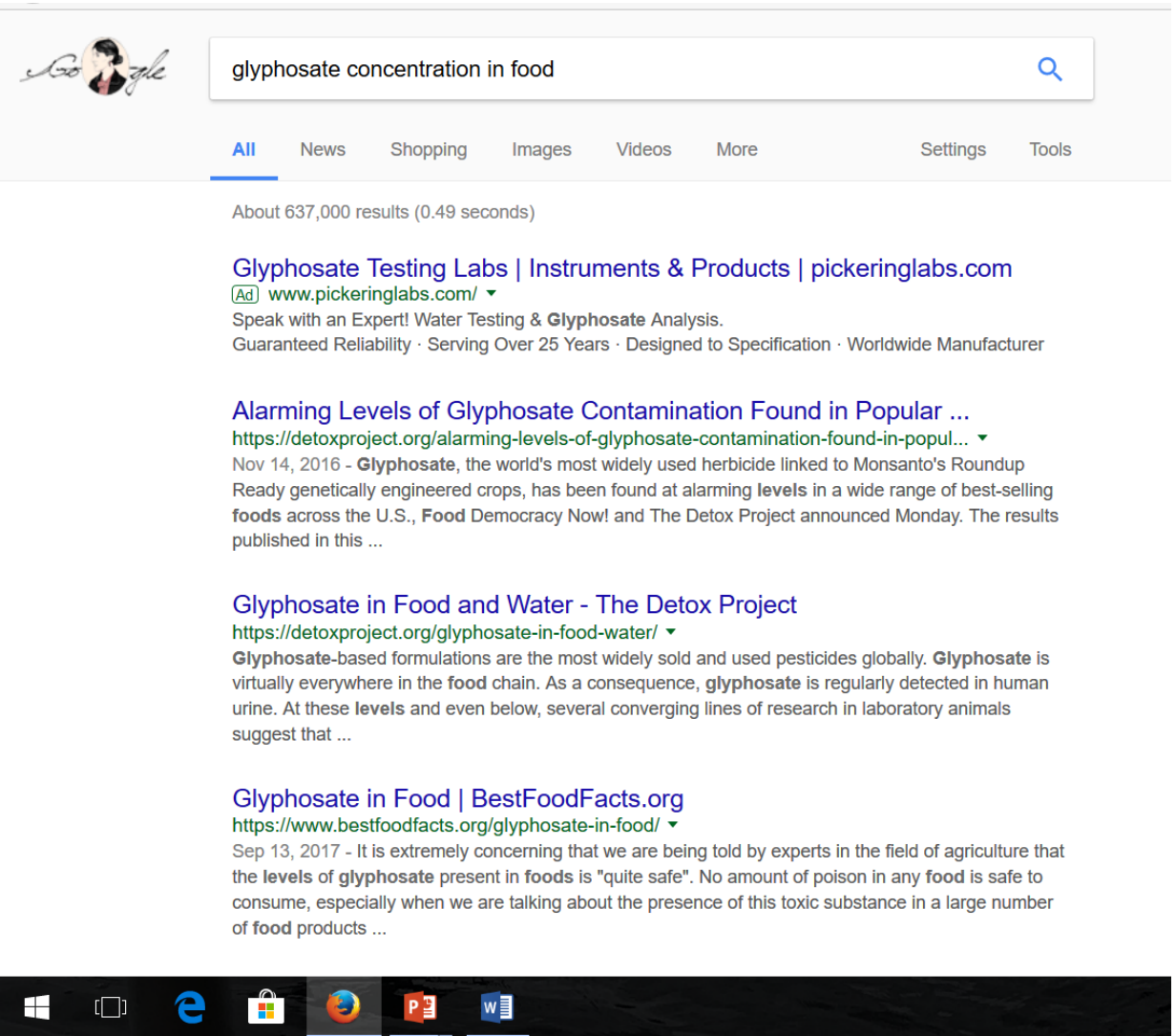
Other Opinions?

EPA assigned tolerances for glyphosate exposure (required to regulate)

- acceptable daily intake of glyphosate (plus metabolites of glyphosate) for humans (ADI, cPAD) = 1.0 mg/kg/day
  - Previous studies have listed it at 1.75 mg/kg/day.
- Estimated potential human intake of glyphosate from food, air, water to see how close ingestion was to this value
  - Very conservative estimate
    - Assumes 100% of crop treated, residues were at max tolerance level, etc

How Much Glyphosate is in our food?

Google search results



- Scientific studies have measured and **found it present in food**.
  - amounts vary depending on use
- residue limits of glyphosate have been reviewed by the European Food Safety Authority in 2015
  - range from 0.025 to 2 mg kg^{-1} in different food sources (EFSA 2015).
- Some experts estimate that dose is too low
  - (Williams et al. 2000).
- Others disagree
  - Bøhn et al. 2014