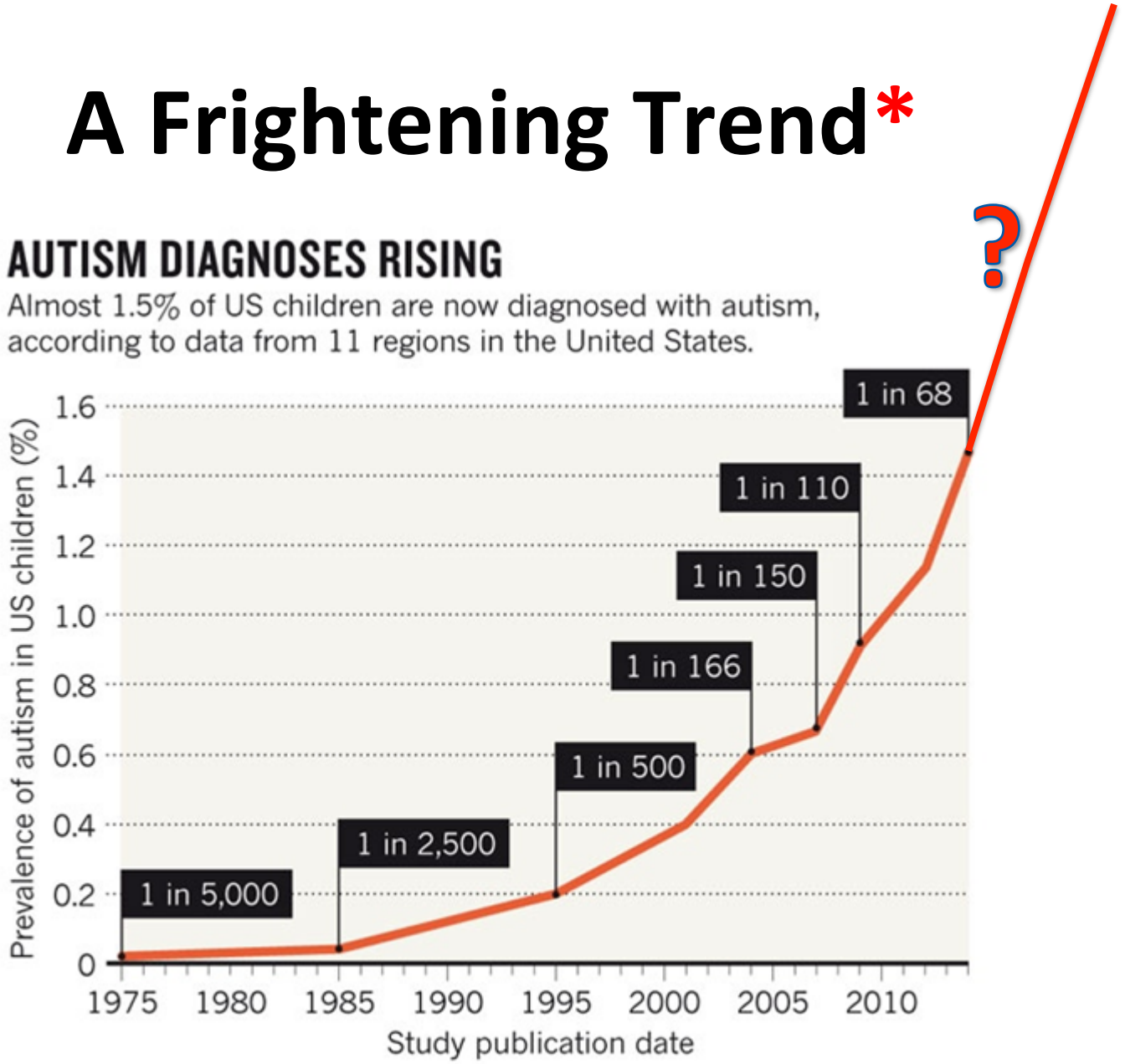
Autism Explained: Synergistic Poisoning from Aluminum and Glyphosate

Stephanie Seneff
MIT CSAIL
May 24, 2014

AutismOne

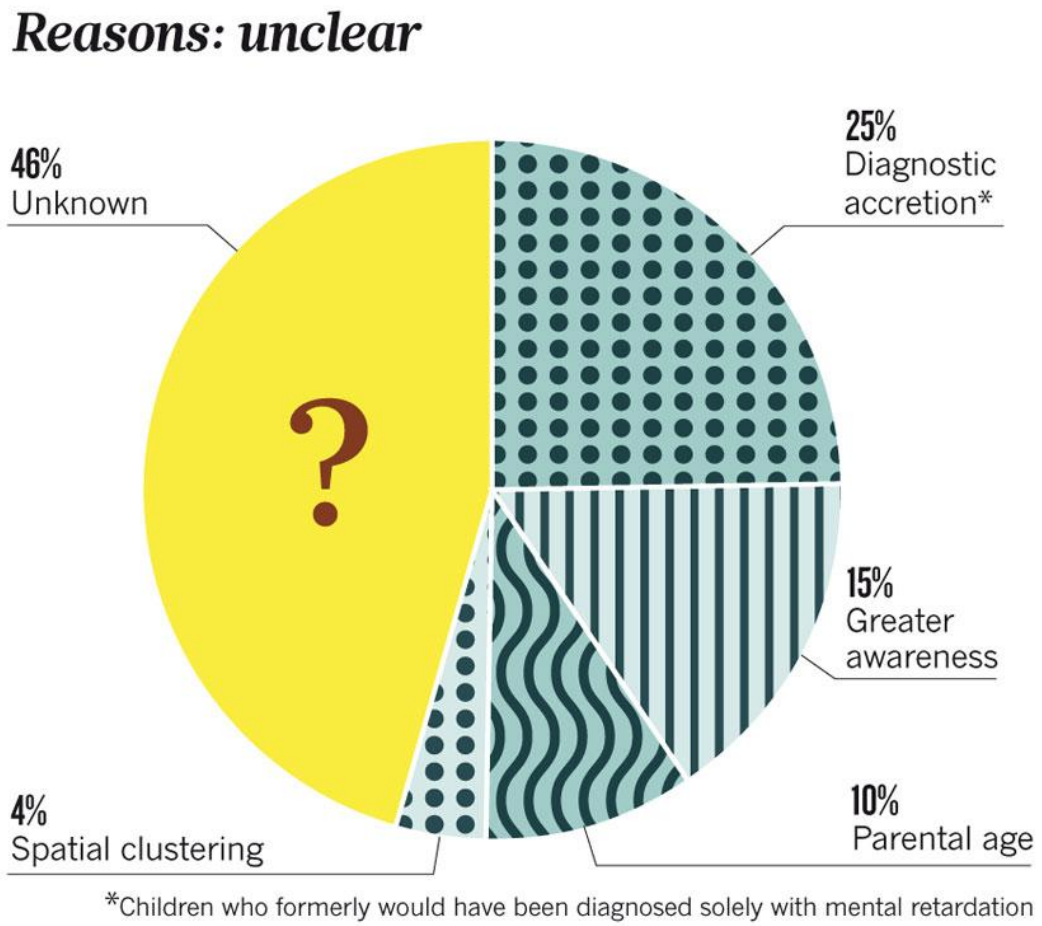
A Frightening Trend*



?

*K. Weintraub, Nature 479, Nov. 3 2011, 22-24.

"If it is an environmental cause contributing to an increase, we certainly want to find it."*



*K. Weintraub, Nature 479, Nov. 3 2011, 22-24.

Sunscreen

Sunglasses

GLYPHOSATE

Poor Diet

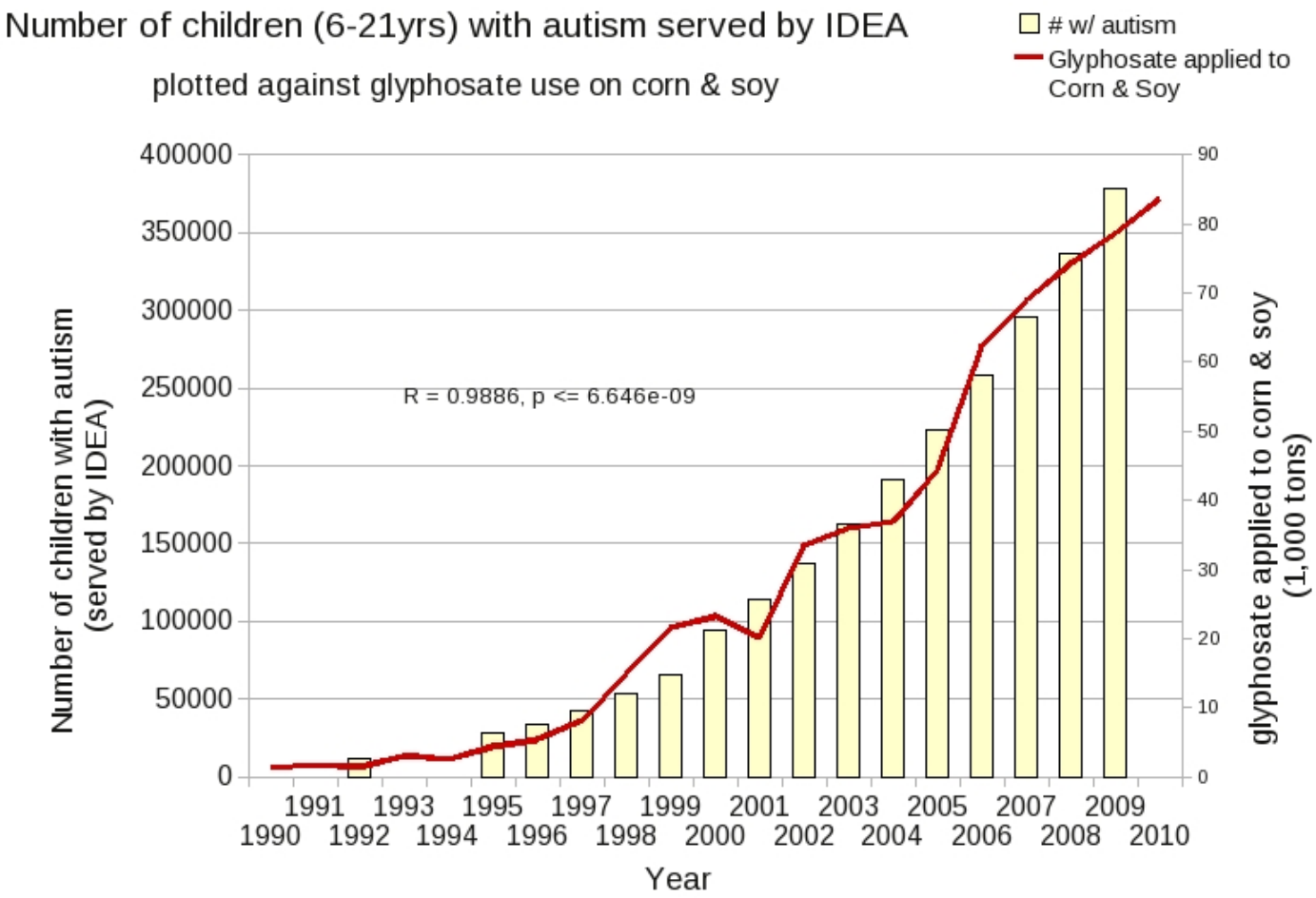
Vaccines

Outline

- Glyphosate and Autism
- Aluminum, glyphosate, sulfate and the pineal gland
  - Sunlight Deficiency
  - Synergistic Effects of Glyphosate and Aluminum
  - Sunlight and Melatonin Sulfate
- Digestive system disorders
- Infertility and Birth Defects
- Glyphosate chelates manganese
  - Lactobacillus and Anxiety
  - Glutamate and Ammonia
  - Mitochondrial Disorder
  - Impaired Bone Development
- How You can Protect Yourself and Your Family

Glyphosate and Autism

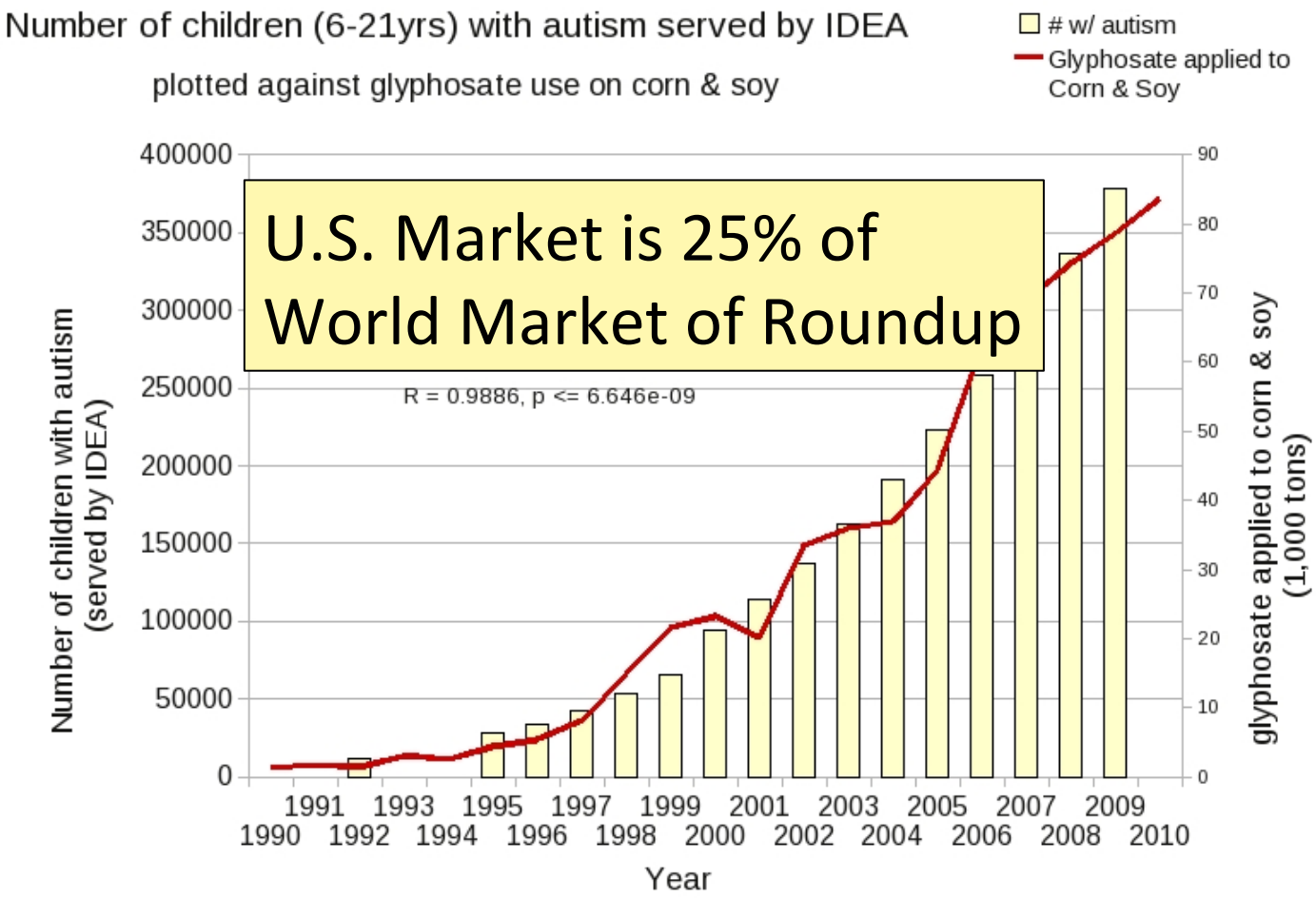
Glyphosate and Autism*



Pearson Correlation Coefficient = 0.99

*Nancy Swanson, http://www.examiner.com/article/data-show-correlations-between-increase-neurological-diseases-and-gmos

Glyphosate and Autism*



Pearson Correlation Coefficient = 0.99

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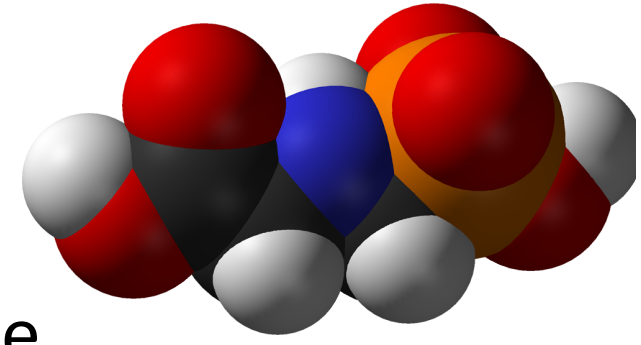
Is Glyphosate Toxic?



- Monsanto has argued that glyphosate is harmless to humans because our cells don't have the shikimate pathway, which it inhibits
- However, our gut bacteria DO have this pathway
  - We depend upon them to supply us with essential amino acids (among many other things)
- Other ingredients in Roundup greatly increase glyphosate's toxic effects
- Insidious effects of glyphosate accumulate over time
  - Most studies are too short to detect damage

Main Toxic Effects of Glyphosate*

- Kills beneficial gut bacteria and allows pathogens to overgrow
- Interferes with function of cytochrome P450 (CYP) enzymes
- Chelates important minerals (iron, cobalt, manganese, etc.)
- Interferes with synthesis of aromatic amino acids and methionine
  - Leads to shortages in critical neurotransmitters and folate
- Disrupts sulfate synthesis and sulfate transport

Samsel and Seneff, Entropy **2013**, *15*, 1416-1463

The Enhancing Effect of Adjuvants*

"Adjuvants in pesticides are generally declared as inerts, and for this reason they are not tested in long-term regulatory experiments. It is thus very surprising that they amplify *up to 1000 times* the toxicity of their APs [Active Principles] in 100% of the cases where they are indicated to be present by the manufacturer."

*R. Mesnage et al.BioMed Research International 2014; Article ID:179691.

Roundup Safety Claims Disputed*

"It is commonly believed that Roundup is among the safest pesticides. … Despite its reputation, *Roundup was by far the most toxic among the herbicides and insecticides tested*. This inconsistency between scientific fact and industrial claim may be attributed to huge economic interests, which have been found to falsify health risk assessments and *delay health policy decisions*."

*R. Mesnage et al., Biomed Research International, Volume 2014 (2014), Article ID 179691

Okay, It's toxic!
But are we exposed?

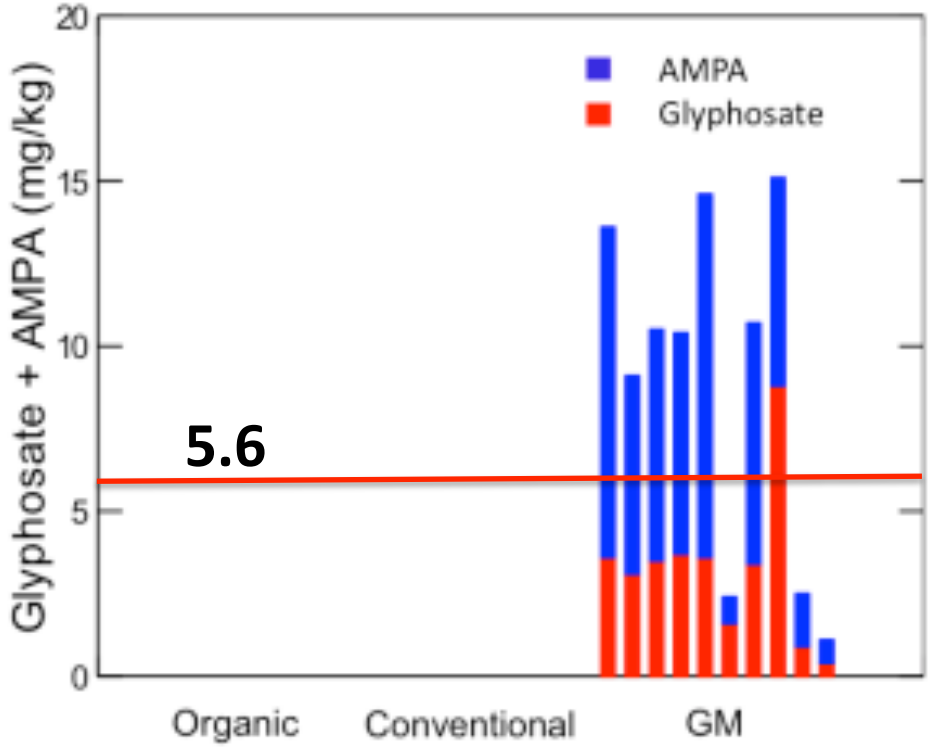
Very little data!

Glyphosate Test Report: Findings in American Mother's Breast milk, urine and water*

- Moms Across America initiative!
- Breast milk levels ranging from 76 ug/l to 166 ug/l are 760 to 1600 times higher than the European Drinking Water Directive allows
- Urine testing shows glyphosate levels over 10 times higher than in Europe
- Monsanto is wrong regarding bioaccumulation

*Posted on Apr 6 2014 - 4:19am by Sustainable Pulse

Study of glyphosate and AMPA (breakdown product) residues in soy crops*



"Another claim of Monsanto's has been that residue levels of up to *5.6* mg/kg in GM-soy represent "...*extreme levels*, and far higher than those typically found" (Monsanto 1999).

www.greenmedinfo.com/blog/how-extreme-levels-roundup-food-became-industry-normal

Soy Formula Linked to Seizures in Autism*

"There was a 2.6-fold higher rate of febrile seizures, a 2.1-fold higher rate of epilepsy comorbidity and a 4-fold higher rate of simple partial seizures in the autistic children fed soy-based formula"

*CJ Westmark, PLOSOne March 12, 2014, DOI: 10.1371/journal.pone.0080488.

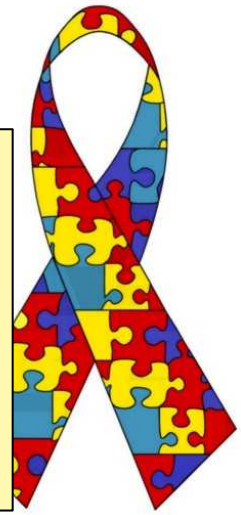
Some Biomarkers for Autism

- Disrupted gut bacteria; inflammatory bowel
- Low serum sulfate
- Methionine deficiency
- Serotonin and melatonin deficiency
- Defective aromatase
- Zinc and iron deficiency
- Urinary p-cresol
- Mitochondrial disorder
- Seizures; Glutamate toxicity in the brain

Some Biomarkers for Autism

- Disrupted gut bacteria; inflammatory bowel
- Low serum sulfate

These can all be explained as potential effects of glyphosate on biological systems



- Zinc and iron deficiency
- Urinary p-cresol
- Mitochondrial disorder
- Seizures; Glutamate toxicity in the brain

"Microbiology of Regressive Autism"*

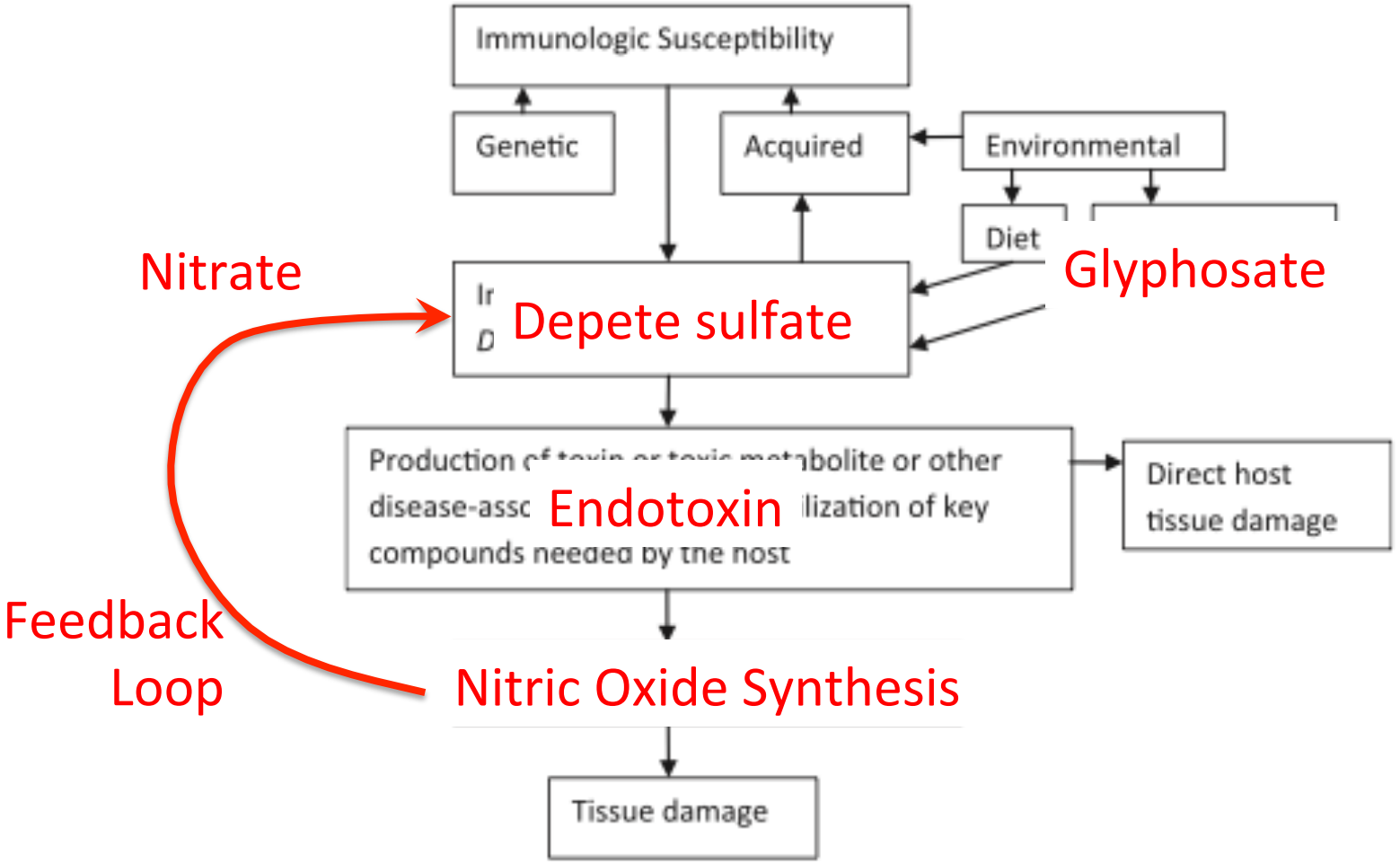
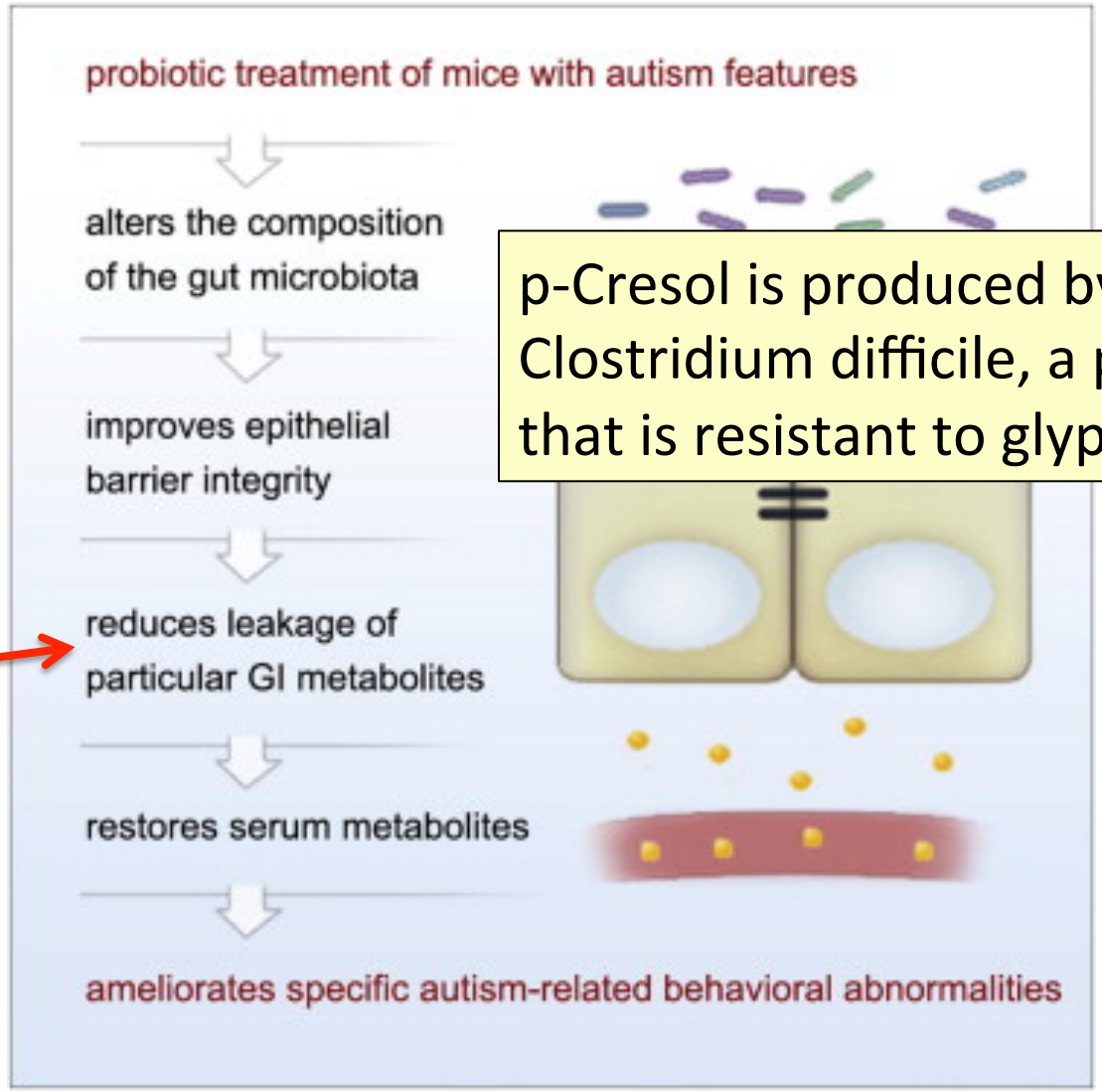


Fig. 1. Hypothetical pathogenesis of autism.

* S.M. Finegold et al., Anaerobe 1-3, 2012

Probiotics Treat Mouse Autism*

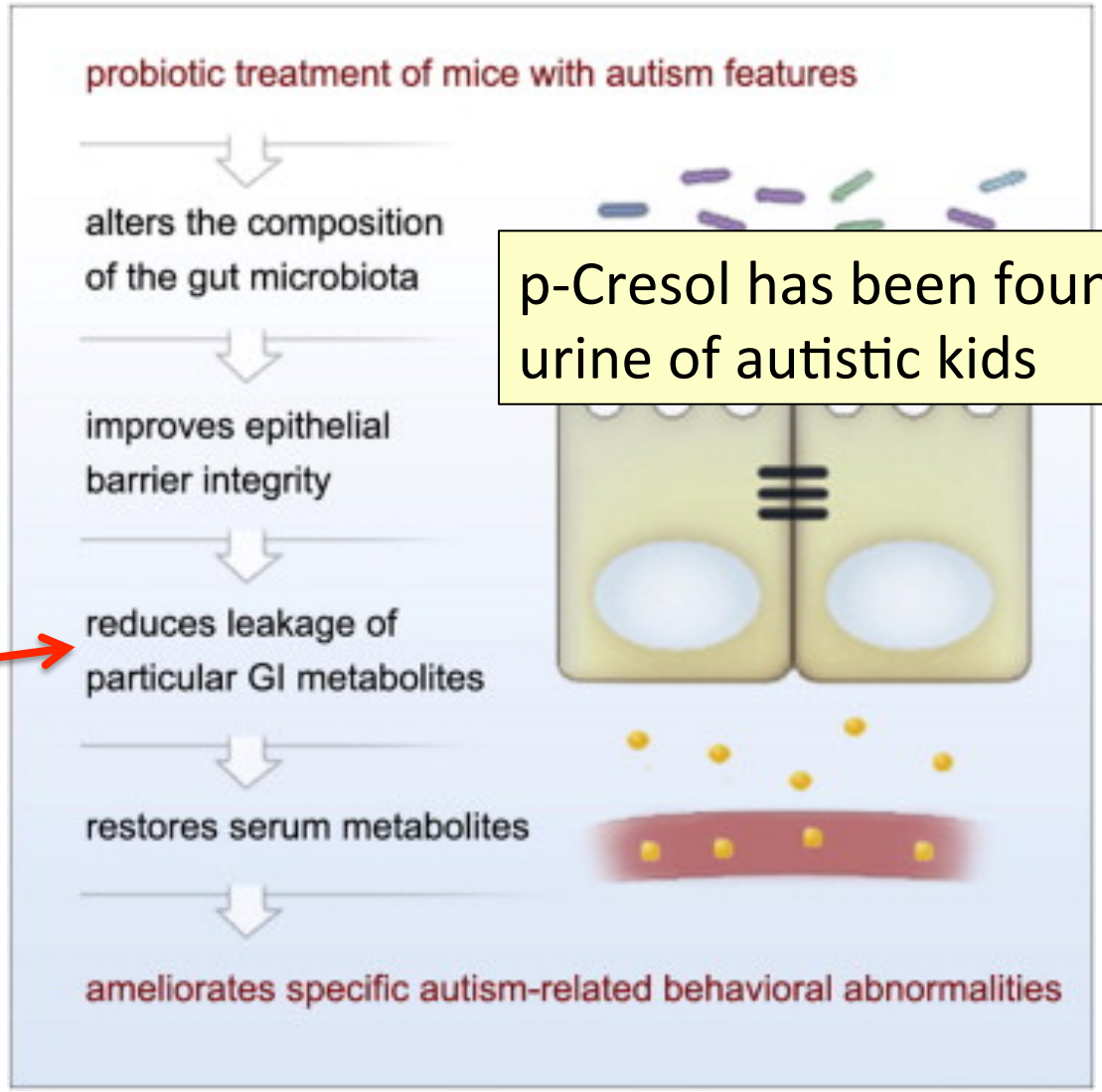


p-Cresol is produced by Clostridium difficile, a pathogen that is resistant to glyphosate

p-Cresol

*Graphical Abstract from E.Y. Hsiao et al., Cell, Dec. 5, 2013

Probiotics Treat Mouse Autism*

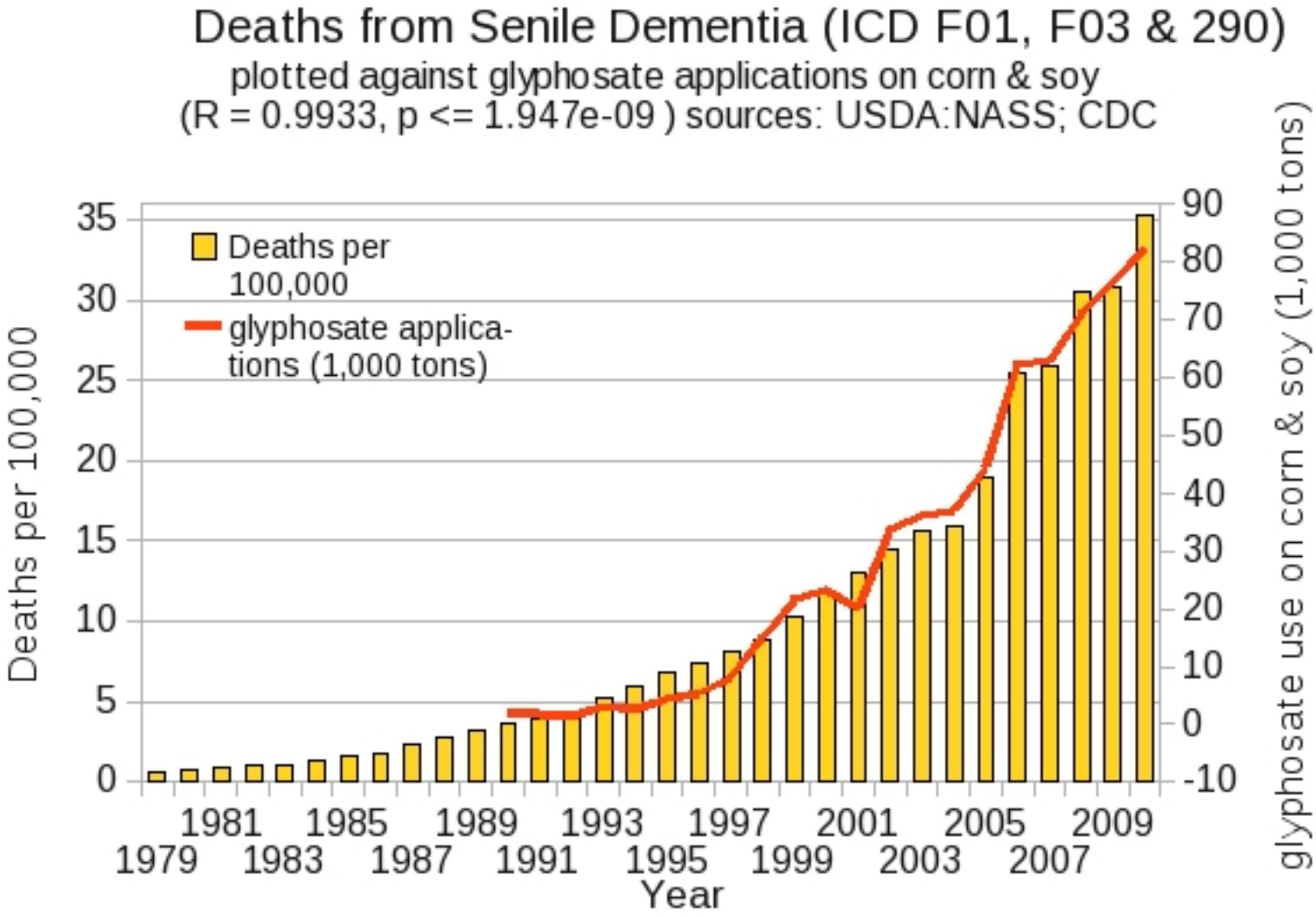


p-Cresol has been found in the urine of autistic kids

p-Cresol

*Graphical Abstract from E.Y. Hsiao et al., Cell, Dec. 5, 2013

Dementia and Autism Have Much in Common



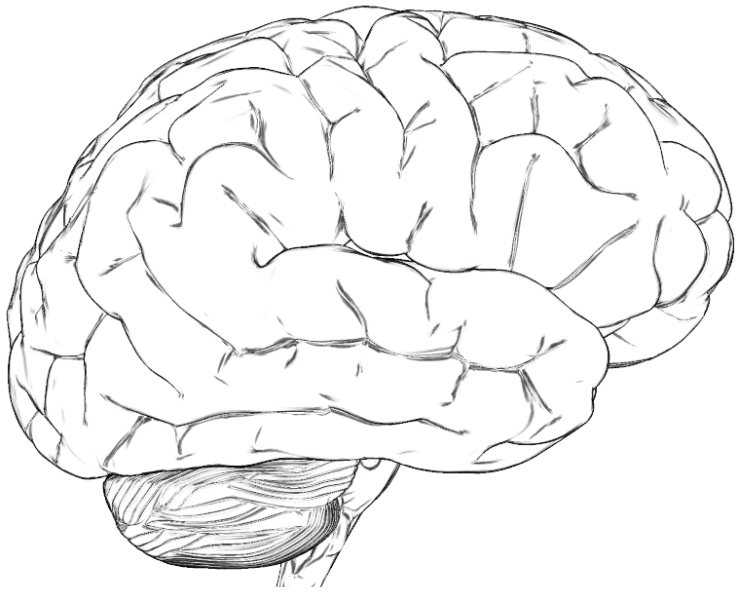
Plot kindly provided by Nancy Swanson

Aluminum, Glyphosate, Sulfate and the Pineal Gland

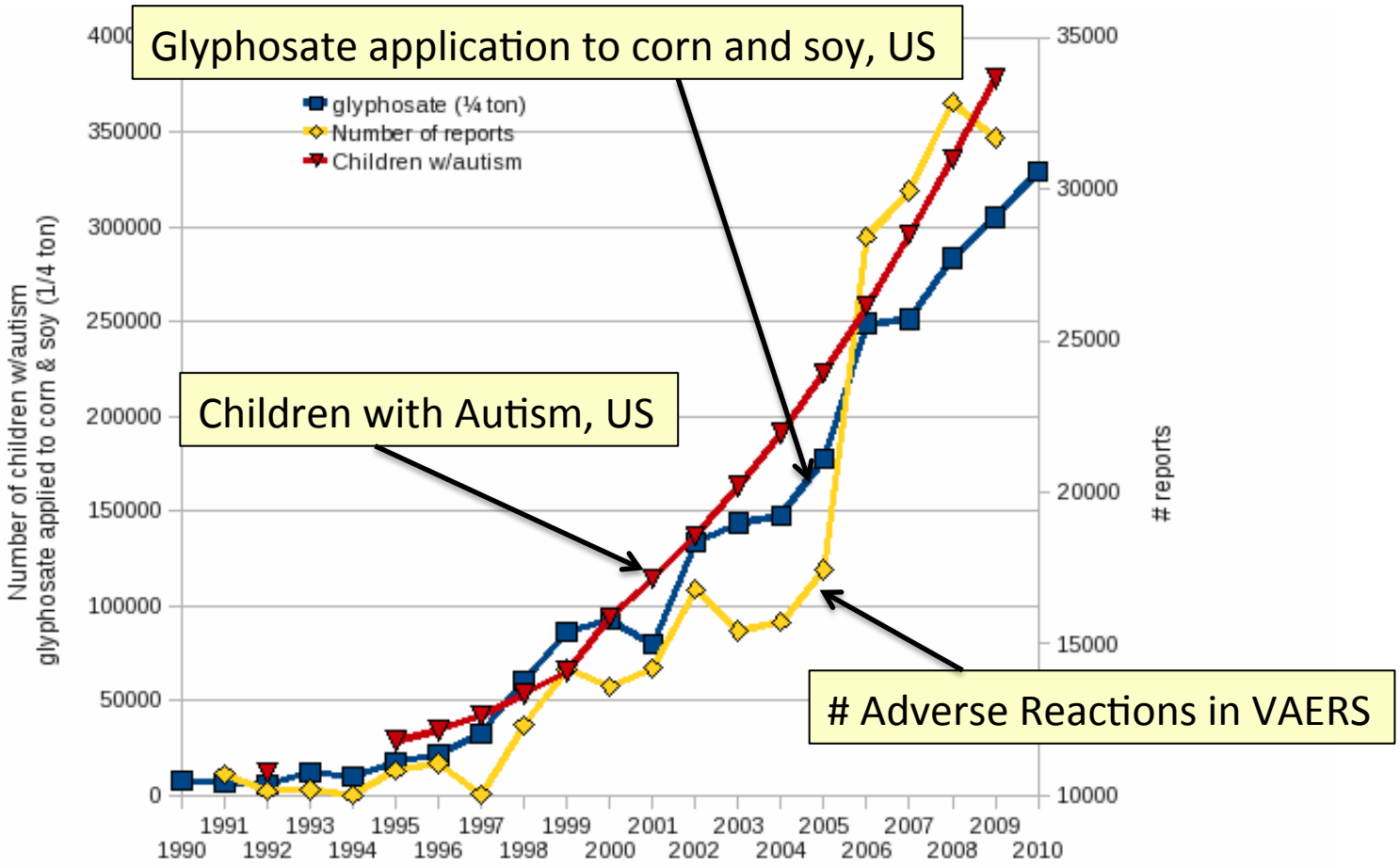
A Hypothesis

Many neurological diseases of the brain have a common origin:

- Insufficient supply of sulfate to the brain
- Powerful burden of toxic metal exposure (e.g., aluminum, mercury) due to impaired ability to detoxify and eliminate them
- Toxic metals interfere with sulfate synthesis
- This results in accumulation of cellular debris



Glyphosate, Autism and Vaccine Reactions*



*Collaboration with Nancy Swanson


GET
YOUR
FLU
SHOT!


get your
flu
shot
here!


BEAT the Flu BUG
Get your Shot!

A New Paper

Int. J. Environ. Res. Public Health **2013**, *10*, 3771-3800; doi:10.3390/ijerph10083771

OPEN ACCESS

International Journal of
Environmental Research and Public Health
ISSN 1660-4601
www.mdpi.com/journal/ijerph

Review

Thimerosal Exposure and the Role of Sulfation Chemistry and Thiol Availability in Autism

Janet K. Kern [1,*], Boyd E. Haley [2], David A. Geier [1], Lisa K. Sykes [3], Paul G. King [3] and Mark R. Geier [1]

Several studies suggest that children diagnosed with an ASD have abnormal sulfation chemistry, limited thiol availability, and decreased glutathione (GSH) reserve capacity, with a resulting and subsequent compromised oxidation/reduction (redox) and detoxification capacity

A Key Factor: Molybdopterin*

- Molybdopterin is a cofactor for the conversion of sulfite to sulfate
- Sulfite is neurotoxic; sulfate is essential
- Mercury can replace the molybdenum atom in molybdopterin, disrupting its function
- Children with autism whose ASD symptoms manifested after 15 months of age had a 50-fold increase in serum sulfite

*JK Kern et al. I*nt. J. Environ. Res. Public Health* **2013**, *10*, 3771-3800;

An Important Role for Sleep

- It has recently been argued that a crucial role for sleep is to clear cellular debris*
- This takes place in the lysosome, which depends upon *sulfate* in heparan sulfate proteoglycans to protect from free radicals**
- I propose that *melatonin* plays a critical role in supplying the sulfate

*Sleep Drives Metabolite Clearance from the Adult Brain. L Xie et al., Science 342:373-377, 2013

**Inhibition by heparin of Fe(II)-catalysed free-radical peroxidation of linolenic acid. M.A. Ross et al., Biochem. J. 1992, 286: 717-720.

Heparin Protects from free radicals due to Iron*

Free radical production:

$$Fe(II) + 0_2 + 20H^- \rightarrow Fe(III)(OH)_2 + 0_2^-$$

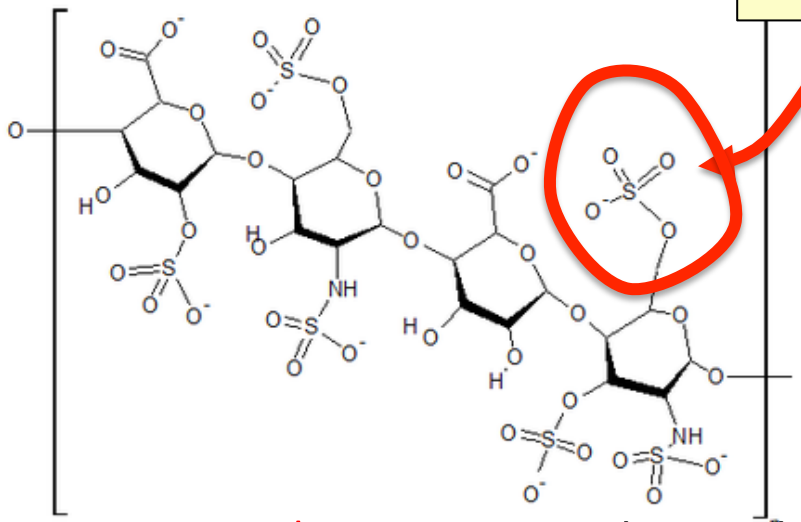
But, in the acid environment of heparin:

$$4Fe(II) + 0_2 + 4H+ \rightarrow 4Fe(III) + 2H_20$$

superoxide

water

sulfate



*M.A. Ross et al., Biochem. J. 1992, 286: 717-720.

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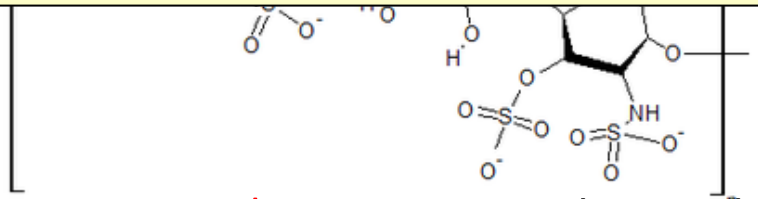
water

Heparin produces acidic environment where reactions with iron produce water (harmless) instead of superoxide (free radicals)



*M.A. Ross et al., Biochem. J. 1992, 286: 717-720.

Heparan Sulfate Deficiency and Autism*

- Experiment with "designer" mice: impaired heparan sulfate synthesis in brain
- Mice exhibited all the classic features of autism – both cognitive and social

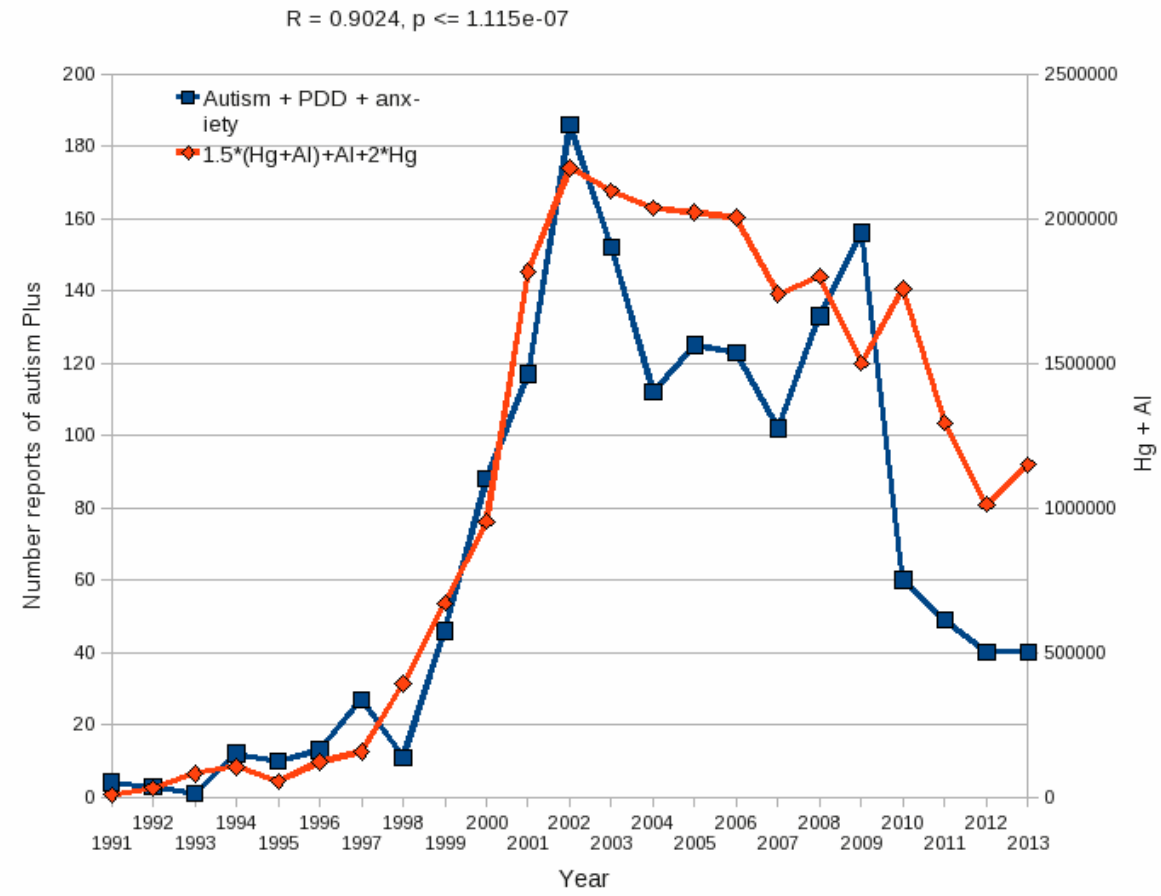
* F. Irie et al., Autism-like socio-communicative deficits and stereotypies in mice lacking heparan sulfate. PNAS Mar. 27, 2012, 109(13), 5052-5056.

Sleep Disorder, Aluminum, and the Pineal Gland

- Sleep disorder is linked to many neurological diseases:
  - Autism, Alzheimer's, depression, schizophrenia, ALS, Parkinson's disease, etc.
- Insomnia occurs much more frequently as an adverse reaction in VAERS to vaccines containing aluminum than to those not containing aluminum ($p = 0.0025$)
- Pineal gland is heavily perfused and outside of the blood brain barrier
  - Susceptible to aluminum toxicity

Aluminum & Mercury

Autism & PDD & Anxiety*

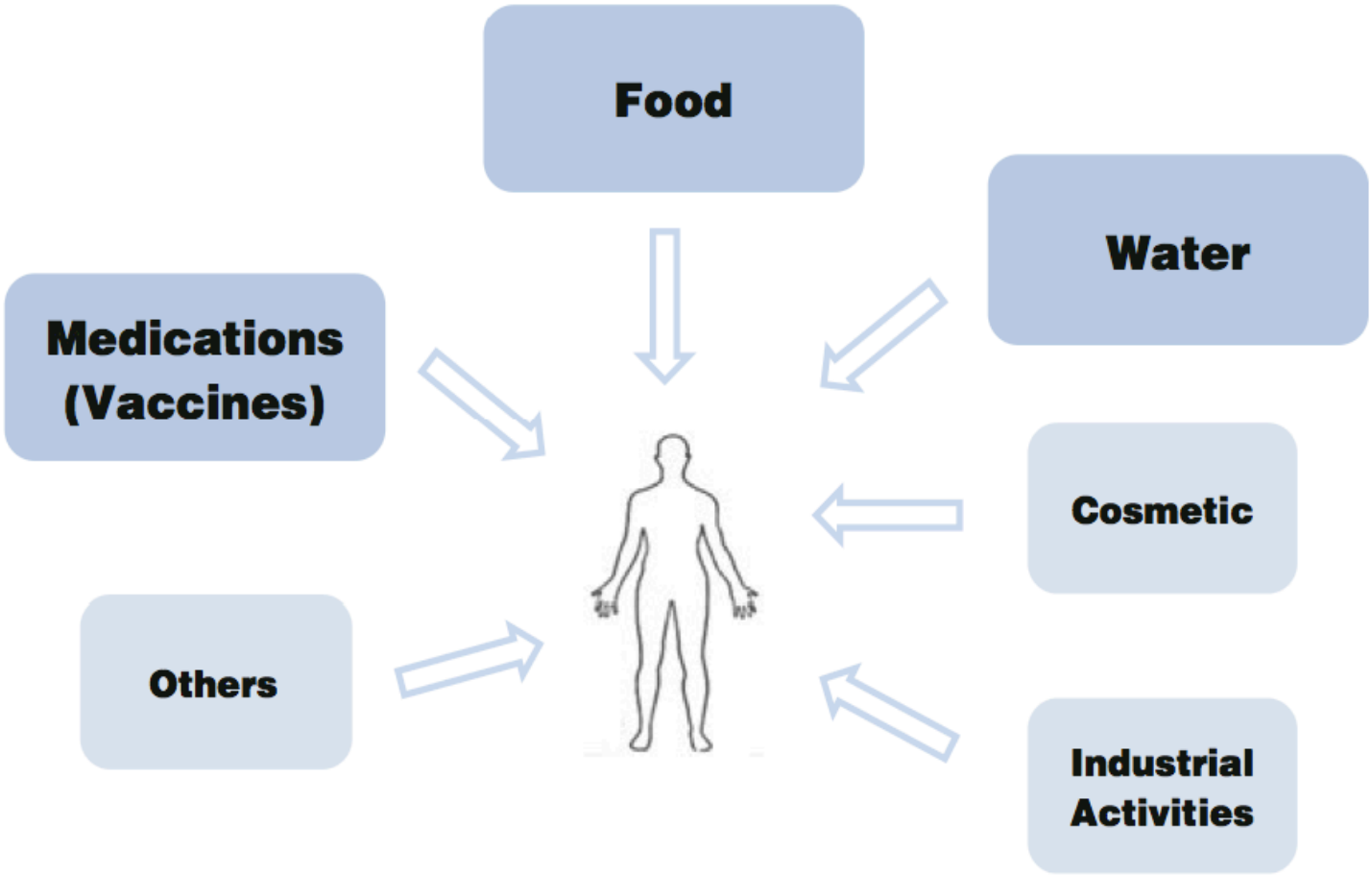


VAERS database

Formula: Al + 1.5 x (Al w/ Hg) + 2.0 x Hg

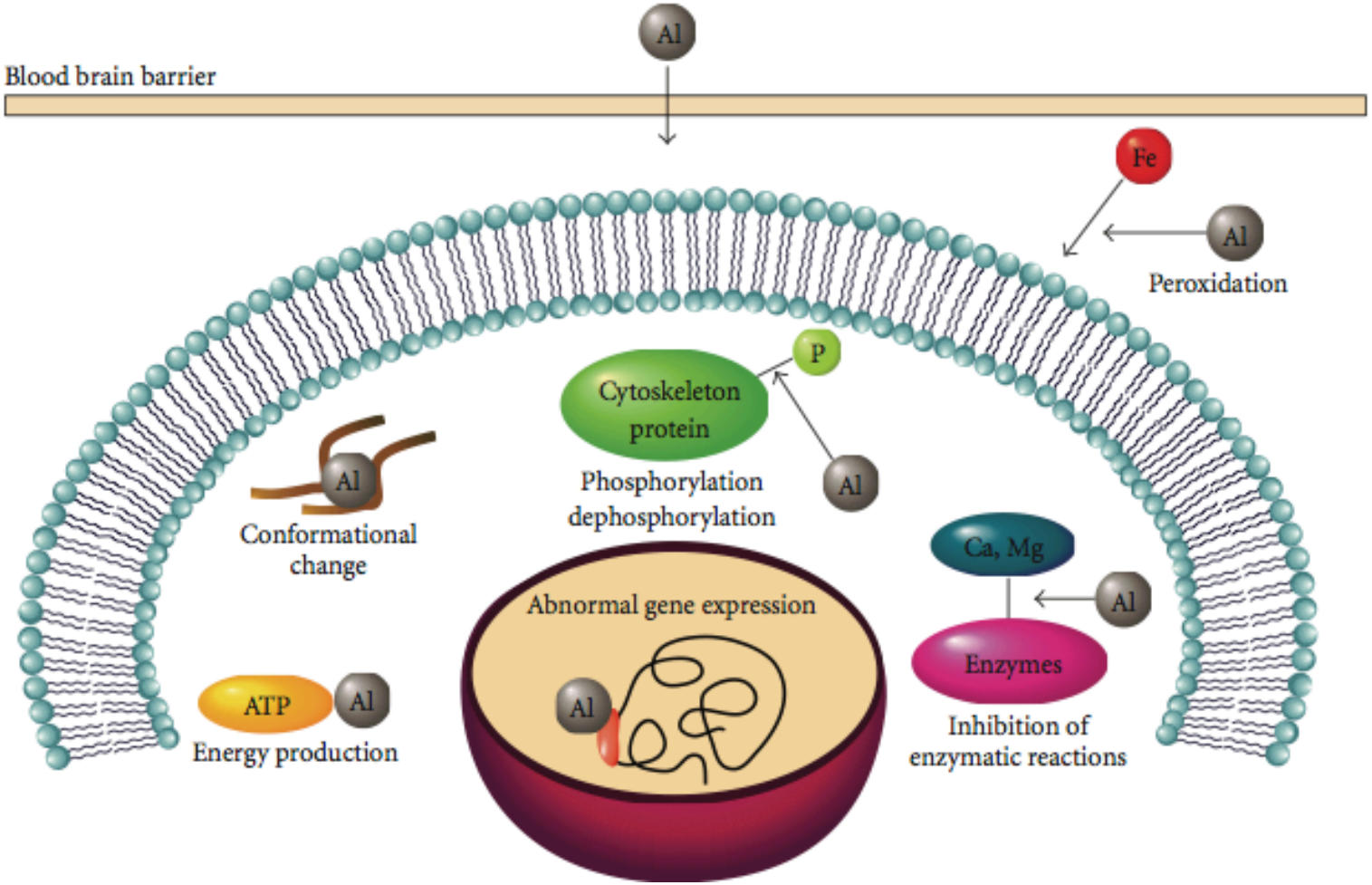
*Data compiled and graphed in collaboration with Nancy Swanson

We live in the age of aluminum*



*C.A. Shaw and L. Tomljenovic, Immunol. Res. Epub ahead of print, 2013

Aluminum's Many Effects in the Brain



Kawahara and Kato-Negishi, International J. Alzheimer's Disease 2011, Article ID 276393

Aluminum in the Pineal Gland*

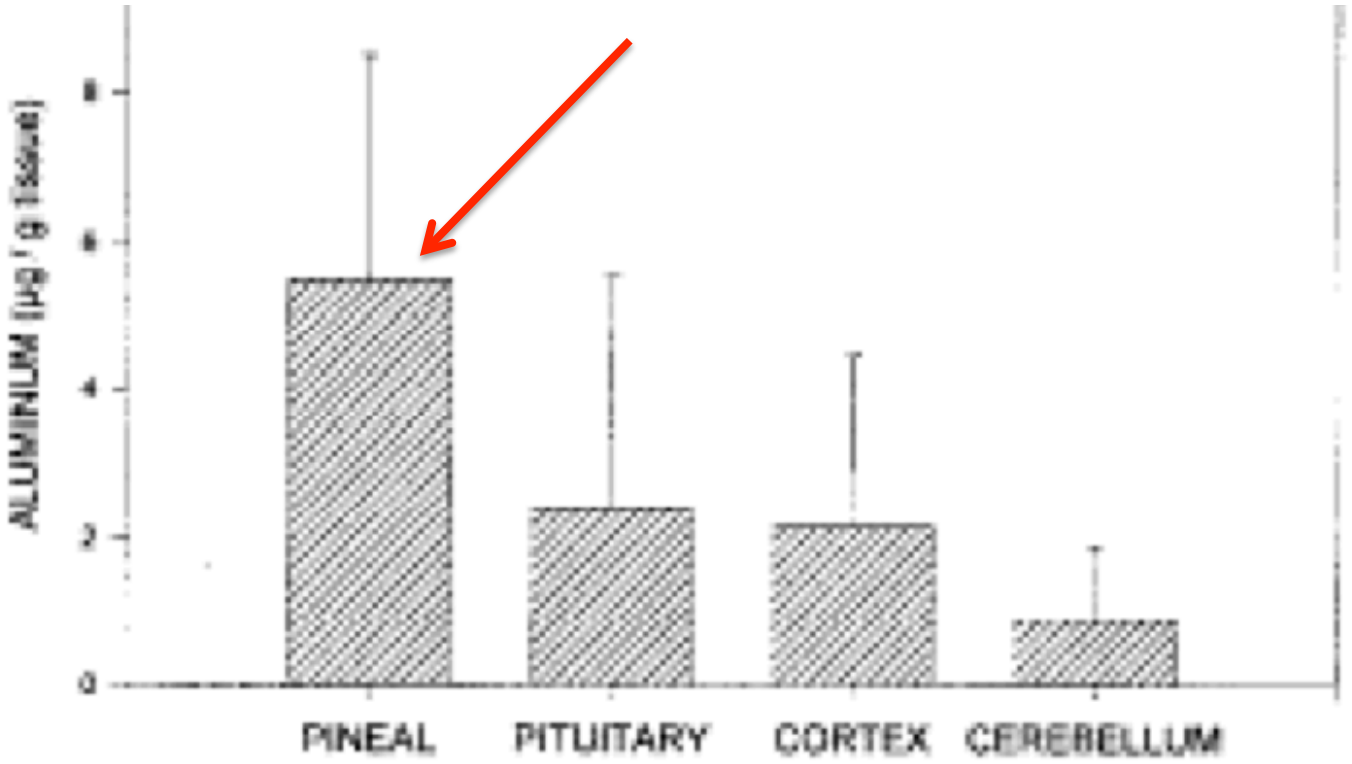
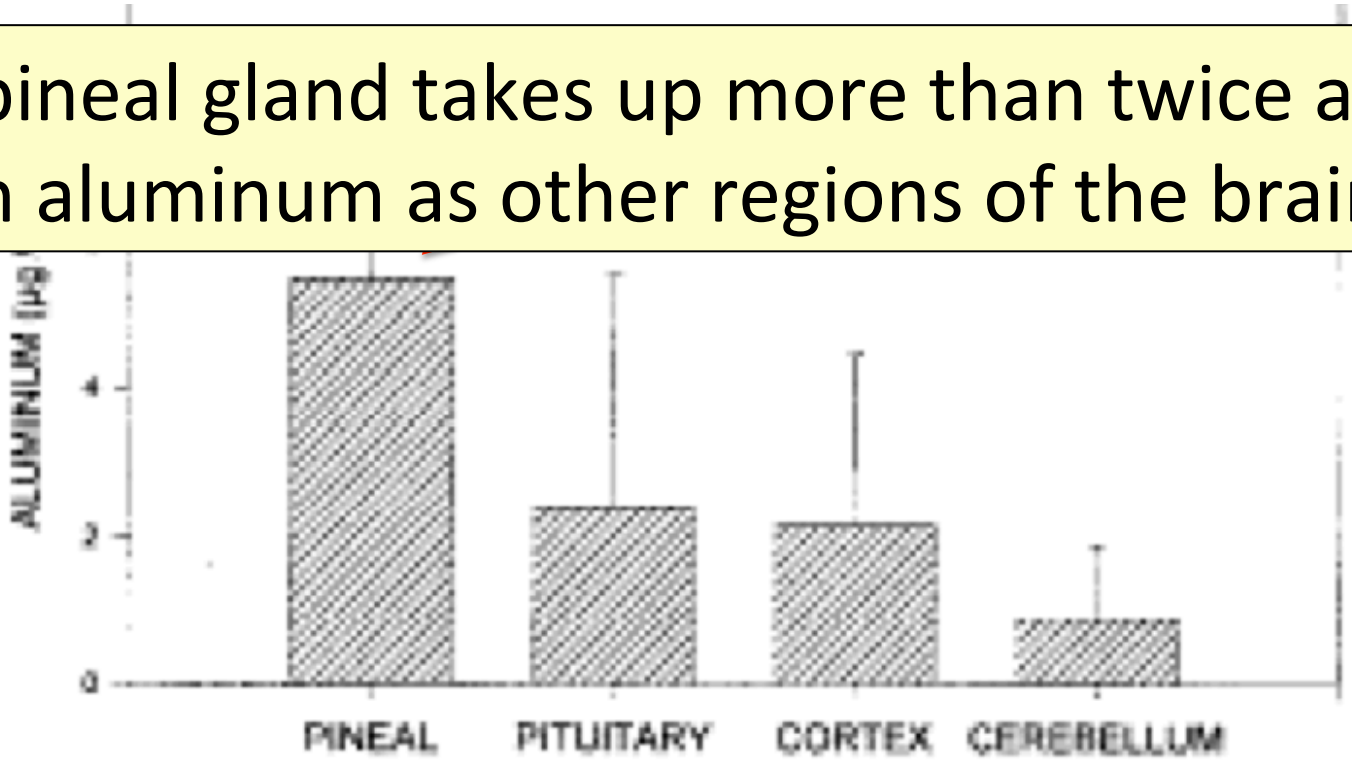


Fig. 6. Aluminum contents of brain tissues (mean ± SD). The results are expressed per unit weight of dried tissues. Four samples of each tissue were examined.

**S.B. Lang et al./Bioclectrochemistry and Bioenergetics 41(1996)191—195*

Aluminum in the Pineal Gland*

The pineal gland takes up more than twice as much aluminum as other regions of the brain



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*S.B. Lang et al./Bioclectrochemistry and Bioenergetics 41(1996)191—195

Sunlight Deficiency

A Critical Role for Sunlight*

- Hypothesis:
  - Endothelial and neuronal nitric oxide synthase (both present in the pineal gland) produce sulfate from reduced sulfur sources catalyzed by sunlight
  - Sulfate deficiency results when this process is impaired
- Aluminum and retinoic acid, present in high SPF sunscreens, interfere with sulfate synthesis in the skin
- Aluminum accumulation in the pineal gland would disrupt sulfate supplies to brain

*S. Seneff et al., Entropy 2012, 14, 2492-2530.

A Really Bad Idea!

Demographic Studies on 50 States

- Public schools in U.S. keep track of # students enrolled in each grade and # students enrolled in programs specifically targeting autism
  - Ratio becomes a measure for autism rate in the state
  - We used grades 1-6 only, in 2007-2008 school year
- We can obtain statistics for many other factors
  - Weather related factors indicate sun exposure
- Pearson's correlation coefficient can be used to detect correlations (ranges from -1.0 to 1.0)
  - Correlation does not necessarily mean causation

Demographics of 50 States

Demographic	Pearson Rating	Explanation
Rank, # clear days	-0.40	Sunlight exposure
Latitude	0.22	Sunlight exposure
Annual rainfall	0.16	Sunlight exposure
RMS (rainfall, latitude)	0.34	Sunlight exposure
Temperature	-0.16	Sunlight exposure
Elevation	-0.28	Sunlight exposure
Vaccination rate	0.38	Aluminum, mercury

All measures of sun availability correlate with autism in such a way that sunlight is protective

Vitamin D Prevents Sulfate Wasting*

- Activated vitamin D prevents sulfate wasting from the kidney in urine
- Mice engineered to have defective vitamin D receptors or with vitamin D deficiency had significantly reduced serum sulfate levels
- This was associated with sulfate depletion in the skeleton

*M.J.G. Bolt et al., Am J Physiol Endocrinol Metab 287: E744 –E749, 2004.

Sulfate in Fetal Development*

- Fetus depends on mother for sulfate supply
- Sulfate is essential for transporting sterols (like estrogen and DHEA) and supplying extracellular matrix proteins everywhere with sufficient negative charge
- Sulfate detoxifies xenobiotics like acetaminophen (tylenol) and is essential for excreting toxins like aluminum and mercury
- Sulfate is severely deficient in autistic children (1/3 the normal level of free sulfate in blood stream)

* Dawson, "Sulfate in Fetal Development," Semin Cell Dev Biol 2011

DHEA Sulfate

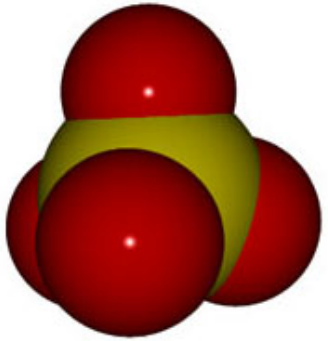
- DHEA is a sterol synthesized from cholesterol
  - Most common steroid in the blood stream
- Autistic adults had significantly lower serum levels of DHEA sulfate*
- DHEA sulfate stimulates dendritic growth in mouse neurons**
  - Genetically engineered mice with defective DHEA synthesis die as 8 day-old embryos

* Strous et al. Neuropsychopharmacol, 15(3):305-9, 2005

** Bair and Melon, Molecular and Cellular Biology 24(12):5383–5390, 2004

Sulfate and Alzheimer's*

- As in autism, Alzheimer's patients have extremely low sulfate levels in the blood
  - Similar reduction to 20% of normal value
- Serum cysteine/sulfate ratio:
  - Alzheimer's 477
  - Parkinson's 521
  - ALS 506
  - Controls 96



- Cysteine levels were not significantly different

* Heafield et al., Neuroscience Letters 110:216-220, 1990

Tylenol and Autism*

- Tylenol is detoxified and eliminated via sulfation
- Autistic kids are severely impaired in this process
  - Reflects reduced supply of sulfate
- Tylenol therapy could result in further depletion of sulfate stores

- This same pathway is necessary to eliminate excess adrenalin and dopamine from the brain
  - Impairment could lead to the formation of neurotoxic substances with psychedelic effects

* Alberti et al., Biol Psychiatry 46, 420–424, 1999.

Adapted from the FASEB J page proofs, 02/18/14
Estimated embargo date is February 26, 2014
Actual embargo date is the date it will appear on the FASEB J website.
Here is link of where the article will appear: http://www.fasebj.org/content/early/recent

The FASEB Journal • Review

Vitamin D hormone regulates serotonin synthesis. Part 1: relevance for autism

Rhonda P. Patrick[1] and Bruce N. Ames[1]

, Oakland,

Glypho Gly cor Glyphosate suppresses tryptophan synthesis by plants and gut bacteria ver

- Autism is associated with low activated vitamin D and low brain serotonin
  - Vitamin D activates serotonin receptors in the brain
- Estrogen rescues females by boosting serotonin levels in brain
- Recommendation is supplements in both vitamin D and tryptophan *(precursor to serotonin)*

Recapitulation

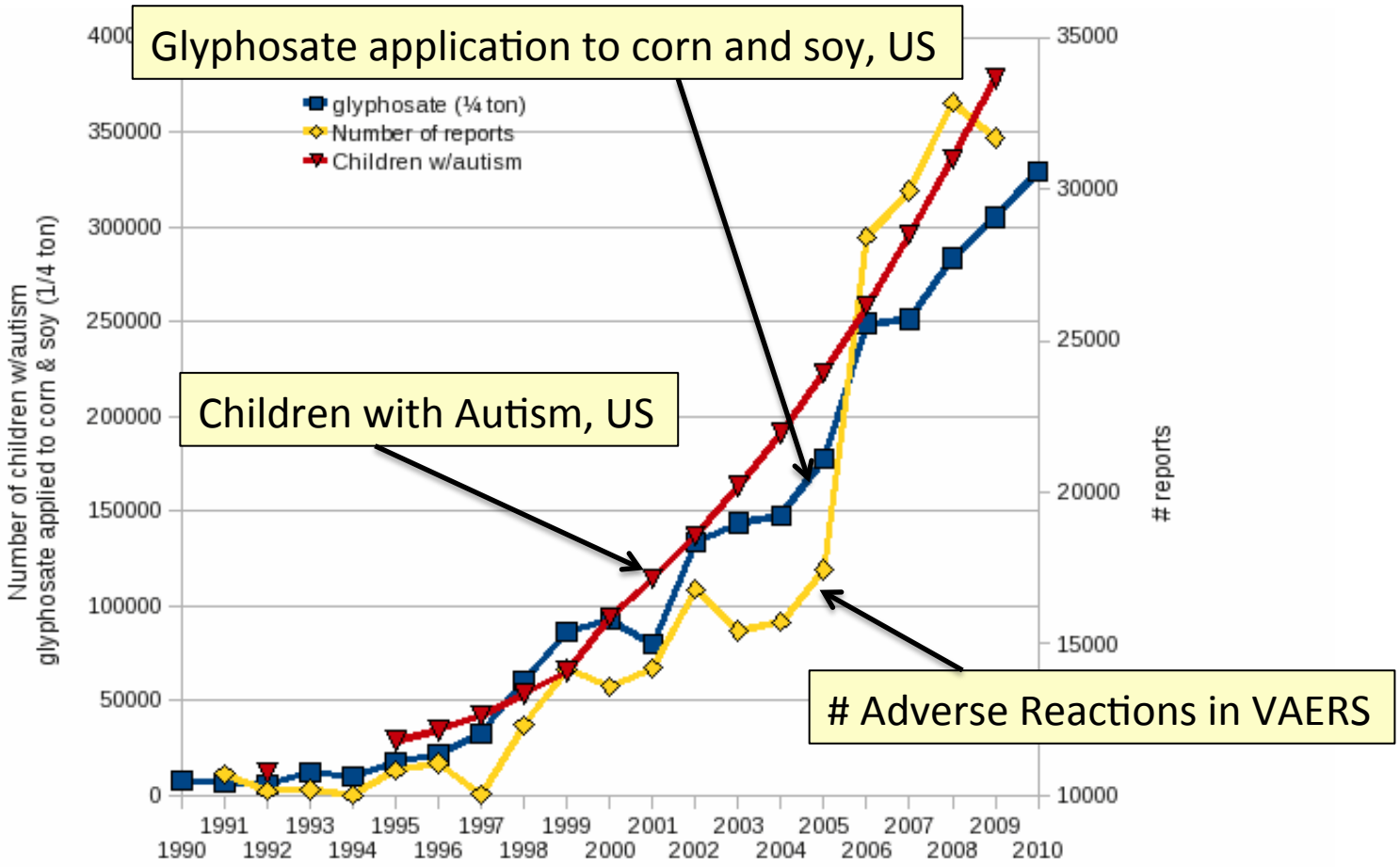
- Measures of sunlight availability based on weather information reveal correlation of less sun with higher autism rates
- Sulfate is synthesized in the skin and in the pineal gland upon sunlight exposure
- Sulfate is essential in the fetus and is supplied by the mother
- Vitamin D prevents sulfate wasting from kidney
- Sulfate deficiency is associated with autism and Alzheimer's
- Vitamin D activates serotonin receptors
  - Impaired serotonin function is associated with autism

Synergistic Effects of Glyphosate and Aluminum

Glyphosate and Aluminum: Partners in Crime

- Glyphosate induces pathogens like C. difficile in gut, leading to *leaky gut syndrome*
  - C. diff produces *p-cresol* which promotes aluminum uptake by cells
  - p-Cresol is a known biomarker for autism
  - p-Cresol is an important factor in *kidney failure* which leads to aluminum retention in tissues → dementia
- Glyphosate *cages* aluminum to promote entry
- Glyphosate promotes *calcium uptake* by voltage-activated channels
  - Aluminum gains entry as calcium mimetic
- Aluminum promotes calcium loss from bones → pineal gland calcification

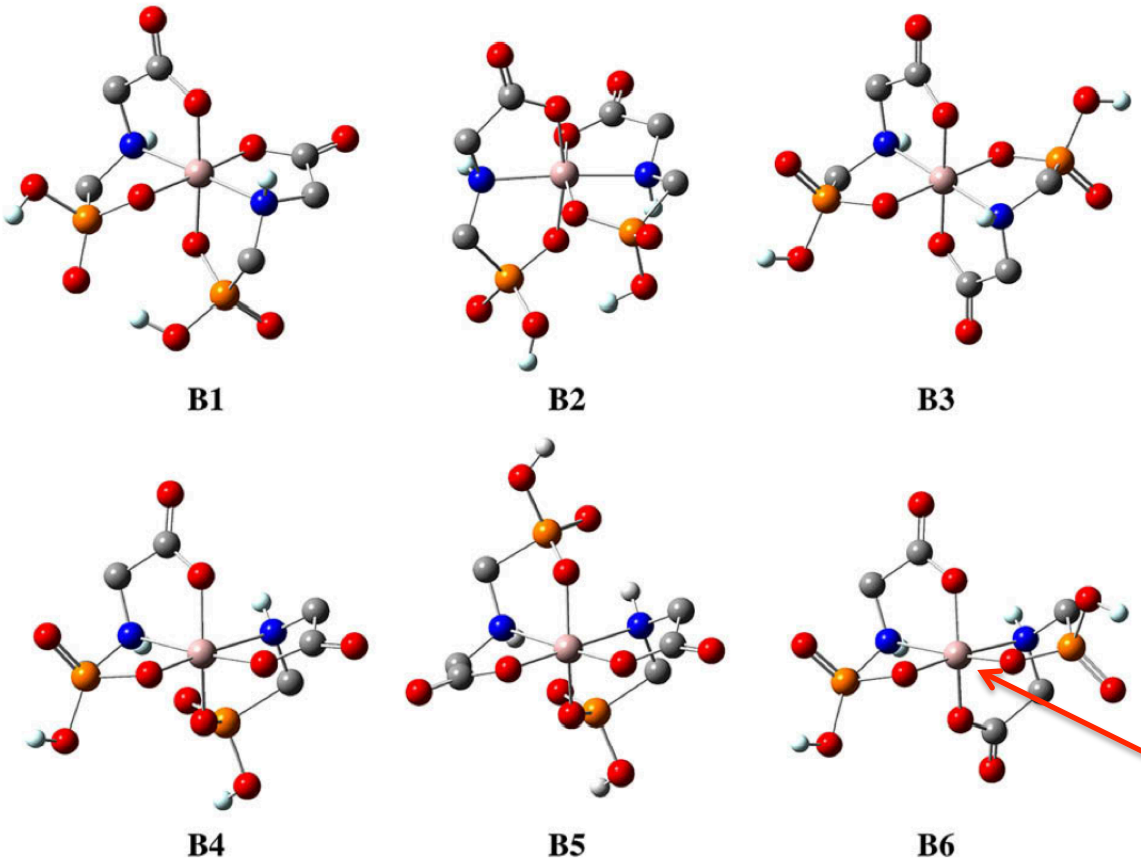
Autism, Glyphosate, Vaccine Reactions*

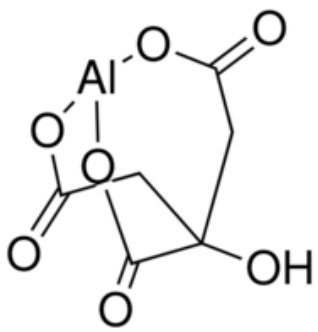


*Collaboration with Nancy Swanson

Aluminum Glyphosate*

Six different ways two glyphosate molecules can chelate aluminum





Aluminum citrate**

aluminum

*M. Purgel et al., Journal of Inorganic Biochemistry 103 (2009) 1426–1438

** P. Sianina et al., Clin. Chem. 32/3, 539-541, 1986.

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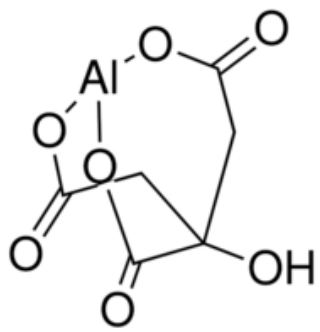
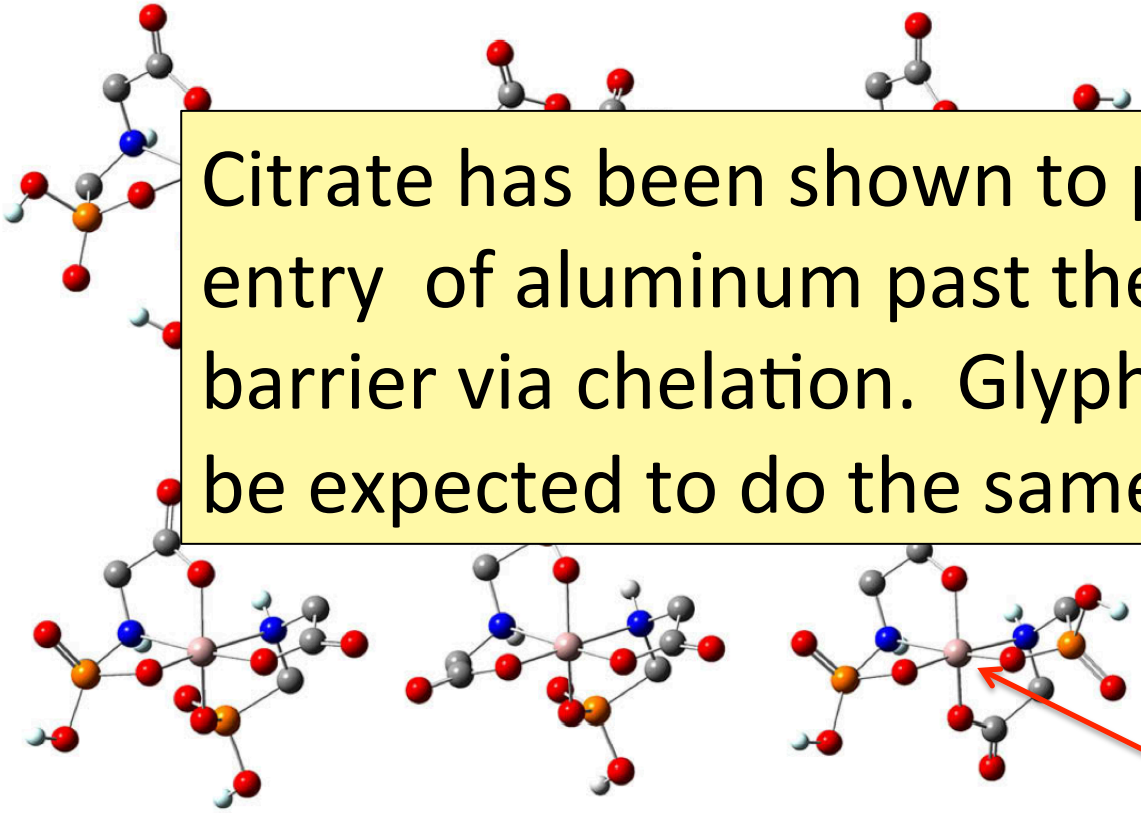
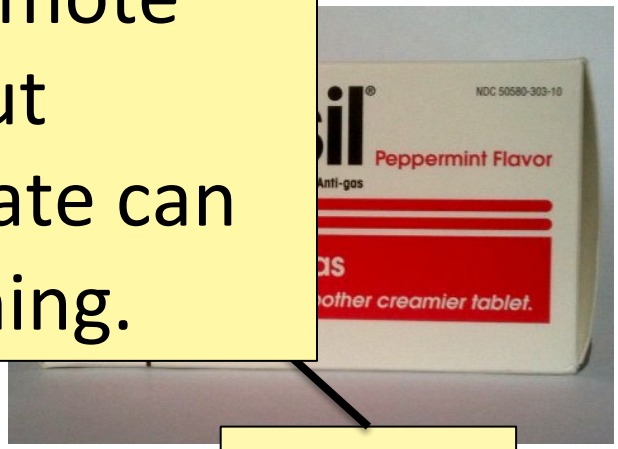


Aluminum citrate**



Citrate has been shown to promote entry of aluminum past the gut barrier via chelation. Glyphosate can be expected to do the same thing.



aluminum

*M. Purgel et al., Journal of Inorganic Biochemistry 103 (2009) 1426–1438

** P. Sianina et al., Clin. Chem. 32/3, 539-541, 1986.

Glyphosate enhances aluminum toxicity

Glyphosate interferes with acetaminophen metabolism

Entropy **2012**, *14*, 2227-2253; doi:10.3390/e14112227

OPEN ACCESS

entropy

ISSN 1099-4300

www.mdpi.com/journal/entropy

Review

Empirical Data Confirm Autism Symptoms Related to Aluminum and Acetaminophen Exposure

Stephanie Seneff [1,*], Robert M. Davidson [2] and Jingjing Liu [1]

Sunlight and Melatonin Sulfate

The Brain

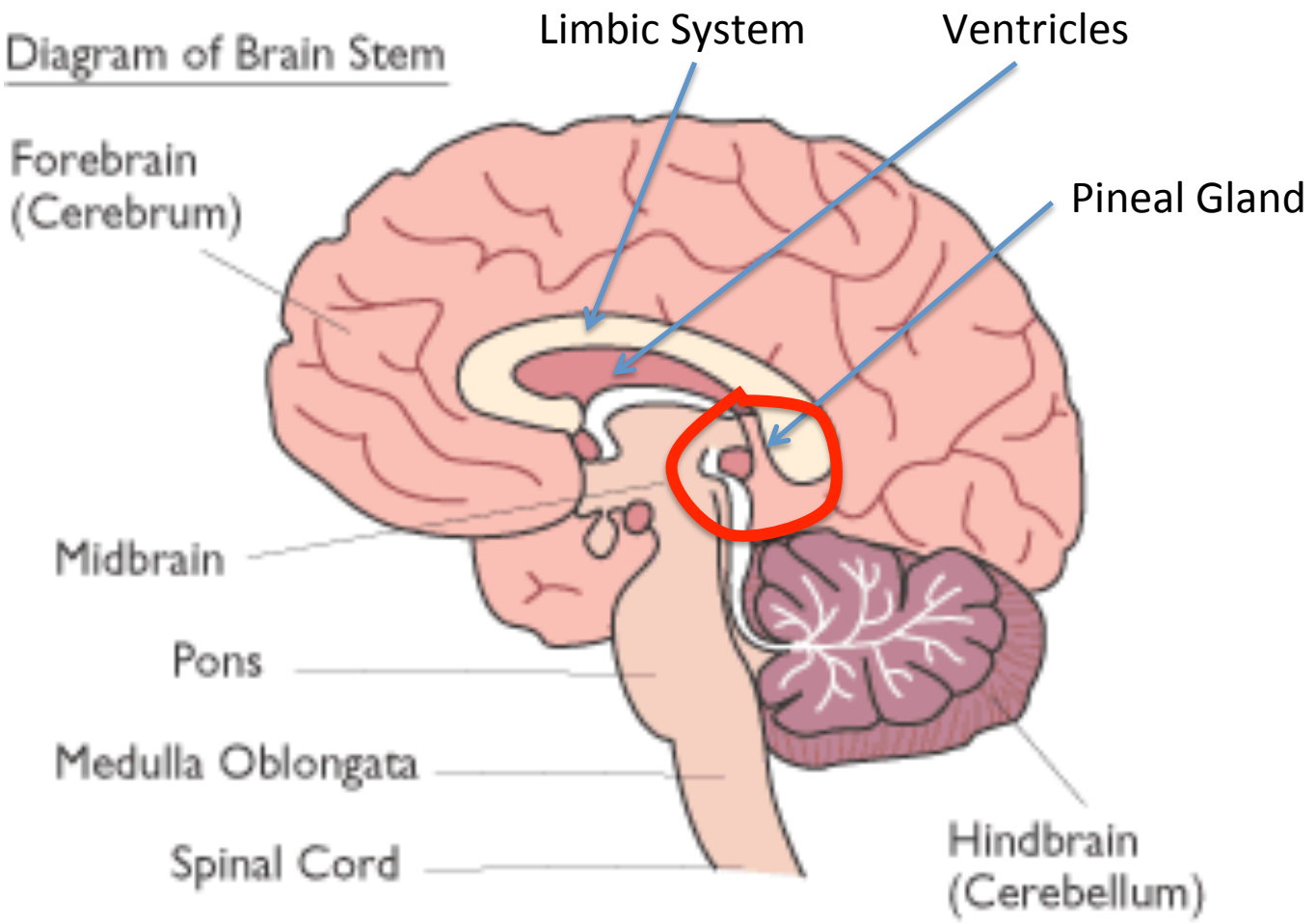
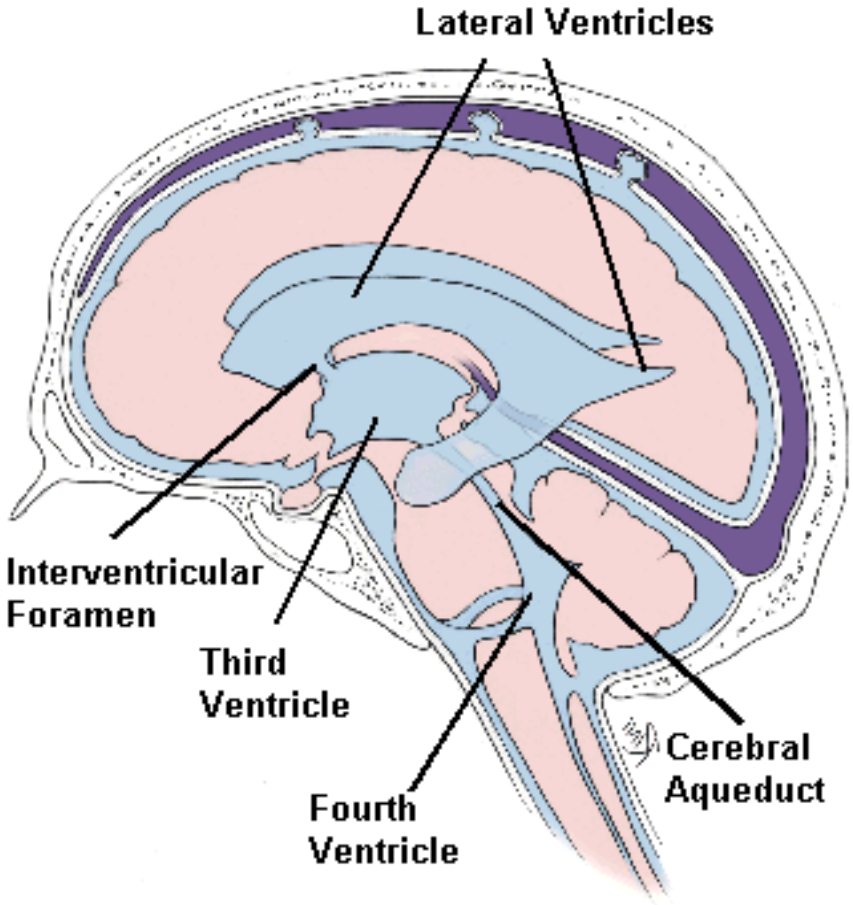


Diagram of Brain Stem
Limbic System
Ventricles
Pineal Gland
Forebrain
(Cerebrum)
Midbrain
Pons
Medulla Oblongata
Spinal Cord
Hindbrain
(Cerebellum)

Ventricles in the Brain

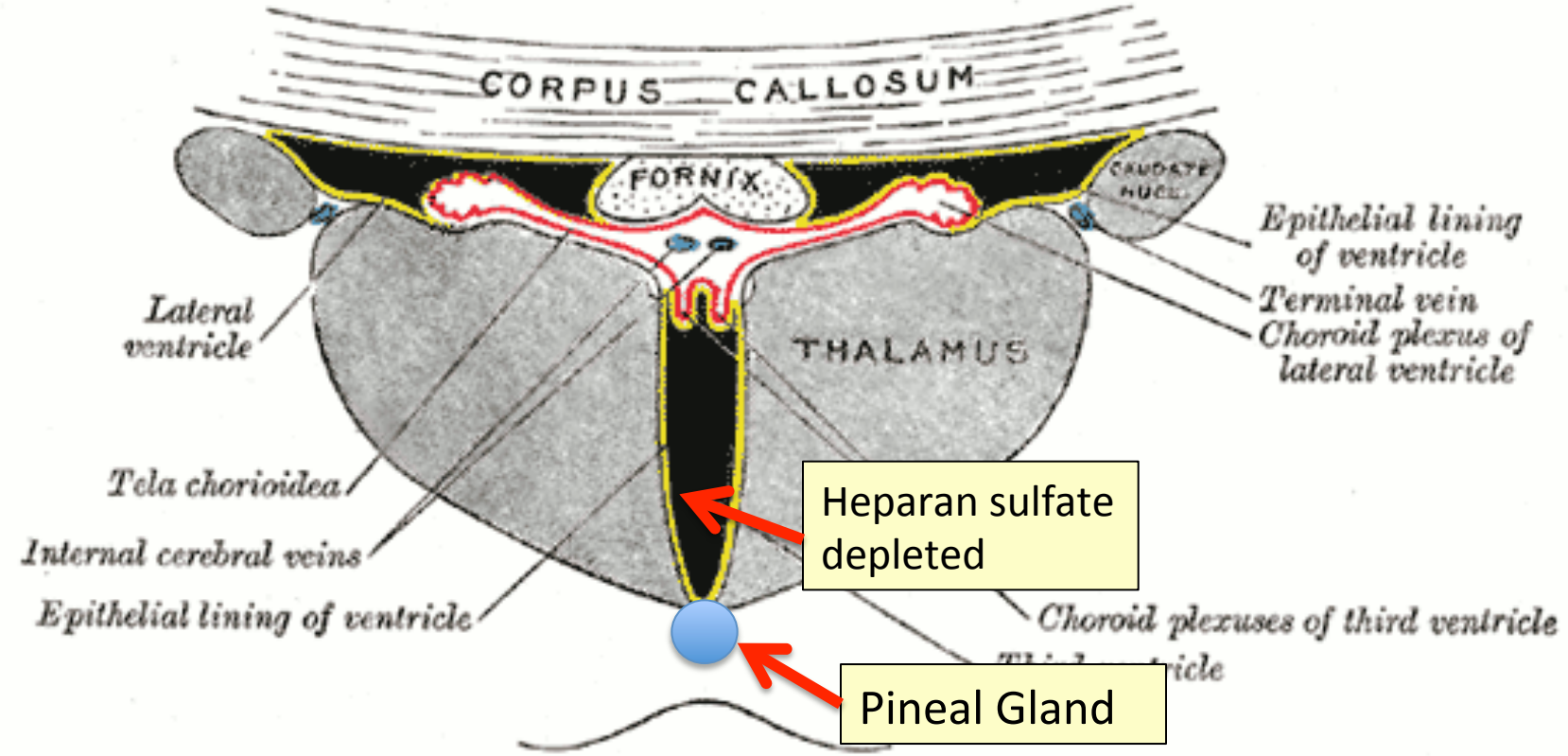


“Heparan Sulfate Deficiency in Autistic Postmortem Brain Tissue from the Subventricular Zone of the Lateral Ventricles”*

*Behav Brain Res. 2013 Apr 15;243:138-45.
doi: 10.1016/j.bbr.2012.12.062.
Epub 2013 Jan 11.

Third Ventricle and Pineal Gland

- Pineal gland is attached to the third ventricle
- The third ventricle is depleted in heparan sulfate in association with autism in both humans and mice*,**

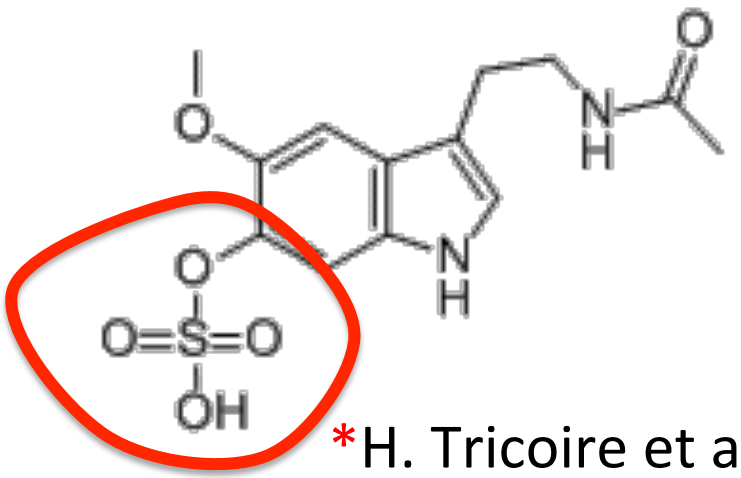


*B.L. Pearson et al., Behav Brain Res. 2013 Apr 15;243:138-45.

**F Mercie et al., Neurosci Lett 506, 2012, 208-213.

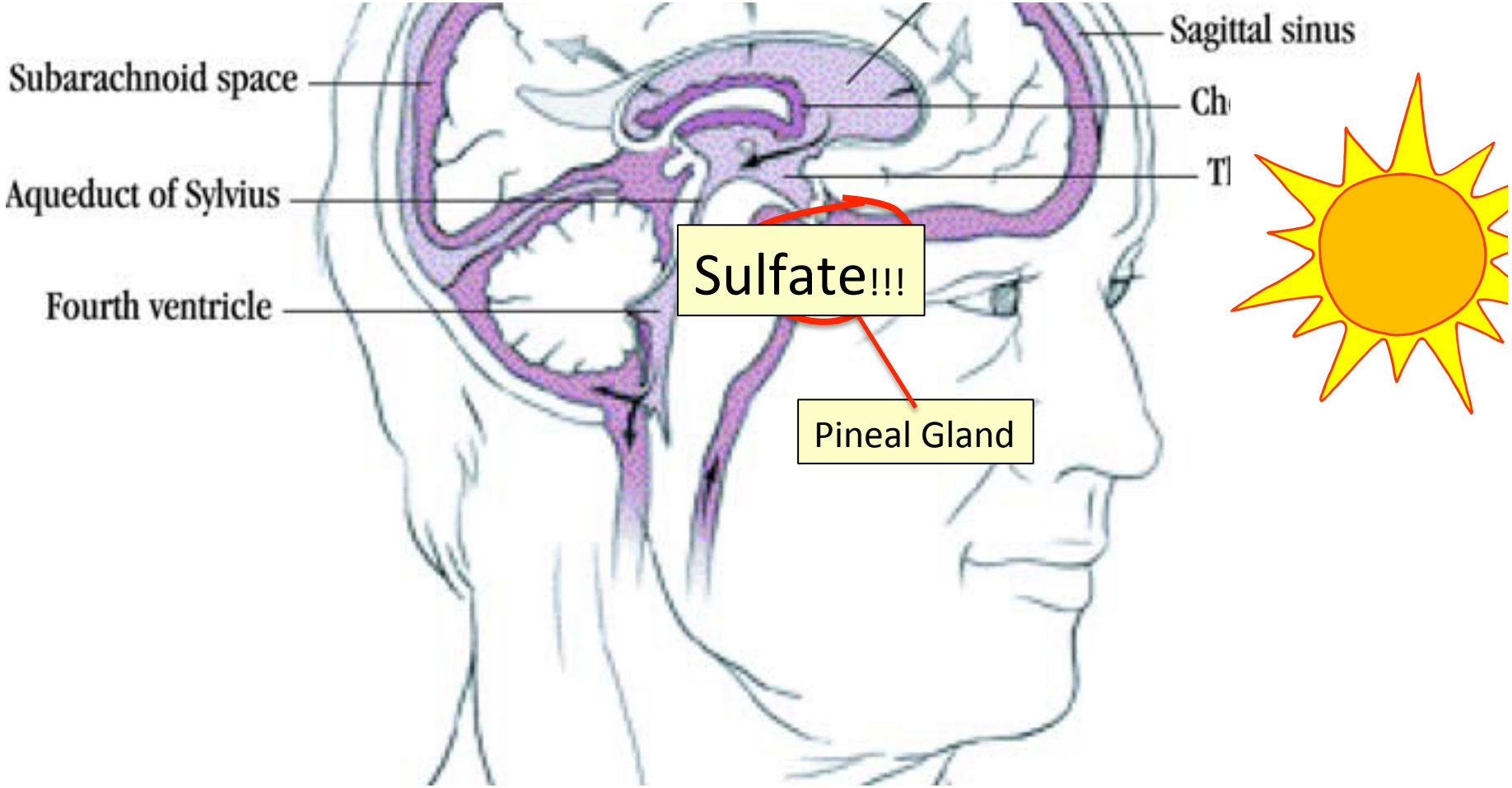
"Melatonin Enters the Cerebrospinal Fluid through the Pineal Recess"*

- The tip of the third ventricle is encased in the pineal gland
- The pineal gland delivers melatonin to the third ventricle and it diffuses to all the cerebrospinal fluid
- I propose that a key purpose of melatonin is to deliver sulfate to the neurons at night.



Melatonin sulfate

*H. Tricoire et al., Endocrinology 143(1):84–90


Subarachnoid space
Aqueduct of Sylvius
Fourth ventricle
Sagittal sinus
Ch
Tl
Sulfate!!!
Pineal Gland

"Light-induced 3-*O*-Sulfotransferase Expression Alters Pineal Heparan Sulfate Fine Structure : A Surprising Link to Circadian Rhythm"*

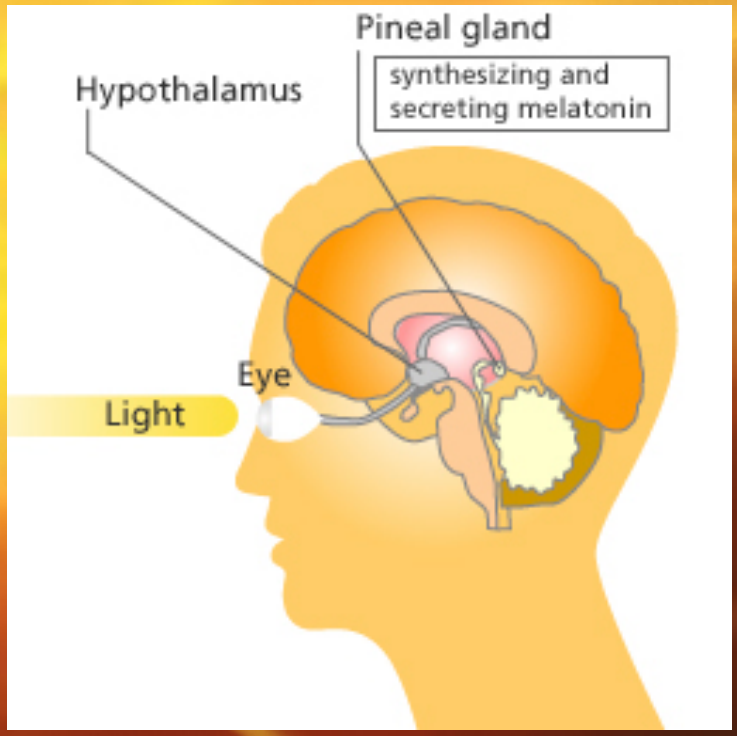
- Pineal gland builds up heparan sulfate supplies *by day*
- Melatonin is sulfated in transport *at night*
  - Highly lipophilic molecule needs sulfate to make it water-soluble
  - This allows it to move through the cerebrospinal fluid
- When melatonin is delivered, sulfate is released!

Melatonin is a sulfate-delivery system!!

*B. Kuberan et al., J. Biol. Chem. 2004, 279:5053-5054.

Pineal Gland: “Seat of the Soul”

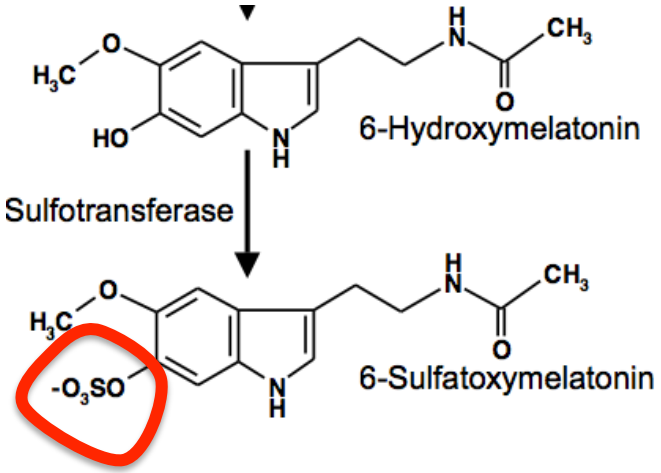
The pineal gland produces sulfate by day (responding to light) and stores it in heparan sulfate molecules



The pineal gland produces melatonin in the evening and transports it as melatonin sulfate to various parts of the brain

REM Sleep Cycle

- Melatonin Induces REM sleep
- Alzheimer's is associated with reduced REM sleep cycle AND calcified pineal gland*



  - Pineal gland calcification correlates inversely with REM sleep**
  - DHEA SULFATE but not DHEA injections increase melatonin production in rats***

*R. Mahlberg et al., Neurobiol Aging. 2008 Feb;29(2):203-9
**R. Mahlberg et al., Sleep Med. 2009 Apr;10(4):439-45.
***Y. Djeridane et al., Steroids. 2004 May;69(5):343-9.

Recapitulation

- Hypothesis: Autism is associated with a severe deficiency in sulfate supplies to the brain
- Pineal gland can synthesize sulfate stimulated by sunlight and deliver it via melatonin sulfate
  - Aluminum, mercury and glyphosate work synergistically to derail this process
- Impaired sleep due to melatonin deficiency characterizes many neurological diseases
- Sunlight deficiency contributes to the pathology

Digestive System Disorders

Dr. Roy Dittman*

"If the microbial world is the substrate for life, why are we waging war on it?"

"The same chemicals we use to sterilize our environment sterilize us."

*Talk at AutismOne Conference, May 25, 2013 Chicago, Illinois

Gut Microbes and Obesity

- Our microbes outnumber our own cells 10 to 1
- There are between 200 and 300 different species in a typical person.
- Glyphosate causes a loss of beneficial bacteria and an overgrowth of pathogens in the gut
  - Pathogens release toxic phenols (e.g., p-cresol)
  - This can lead to inflammatory bowel disease
    - And a direct path to obesity!
- Gut microbes from an obese person induced obesity in mice*

*N. Fei and L. Zhao, The ISME Journal, Online Publication Dec. 2012

Obesity Switch*

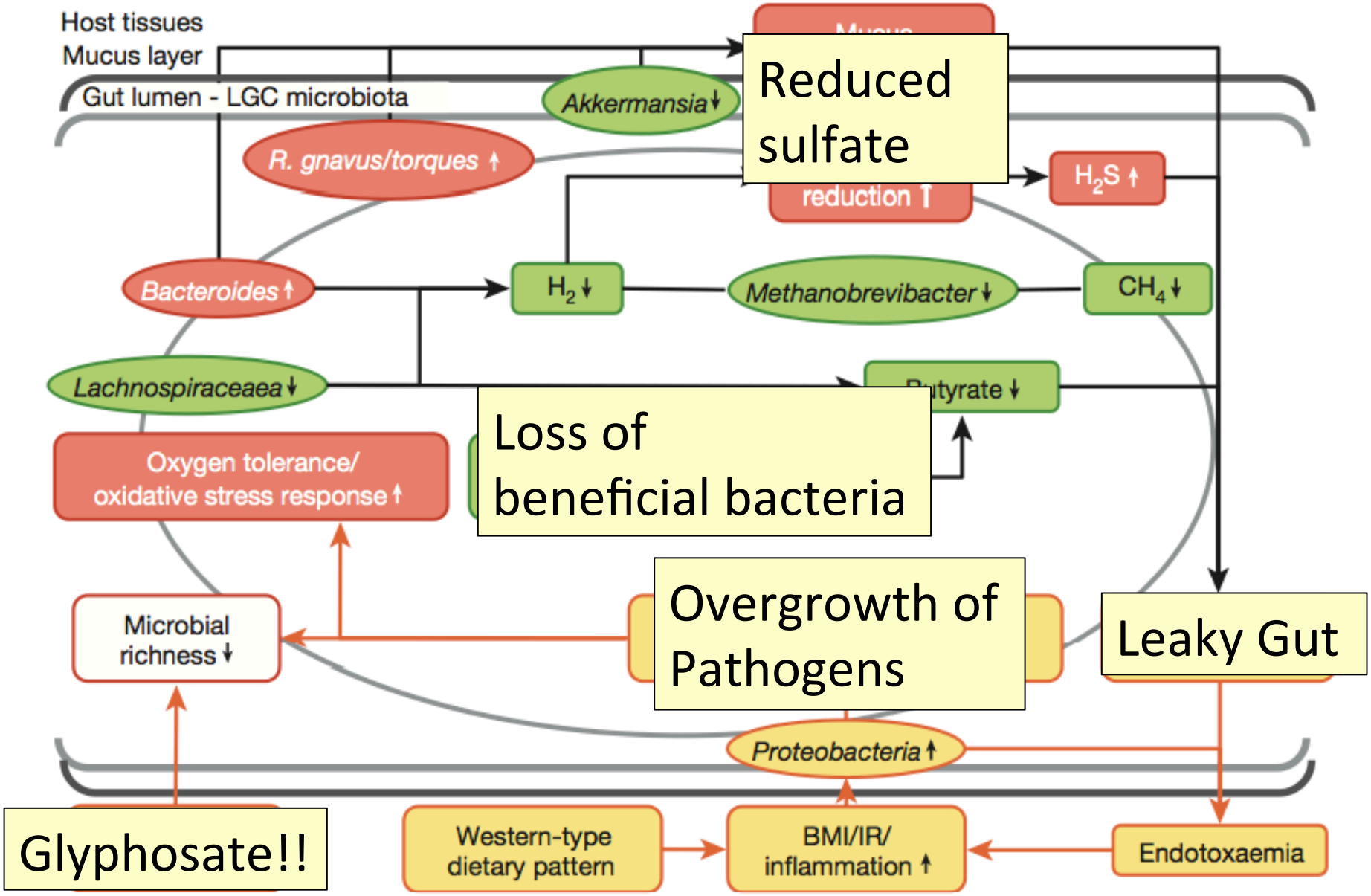


*Figure 3, Le Chatelier et al., Nature 500, Aug 29, 2013, 541-548.

Obesity in US over Time*

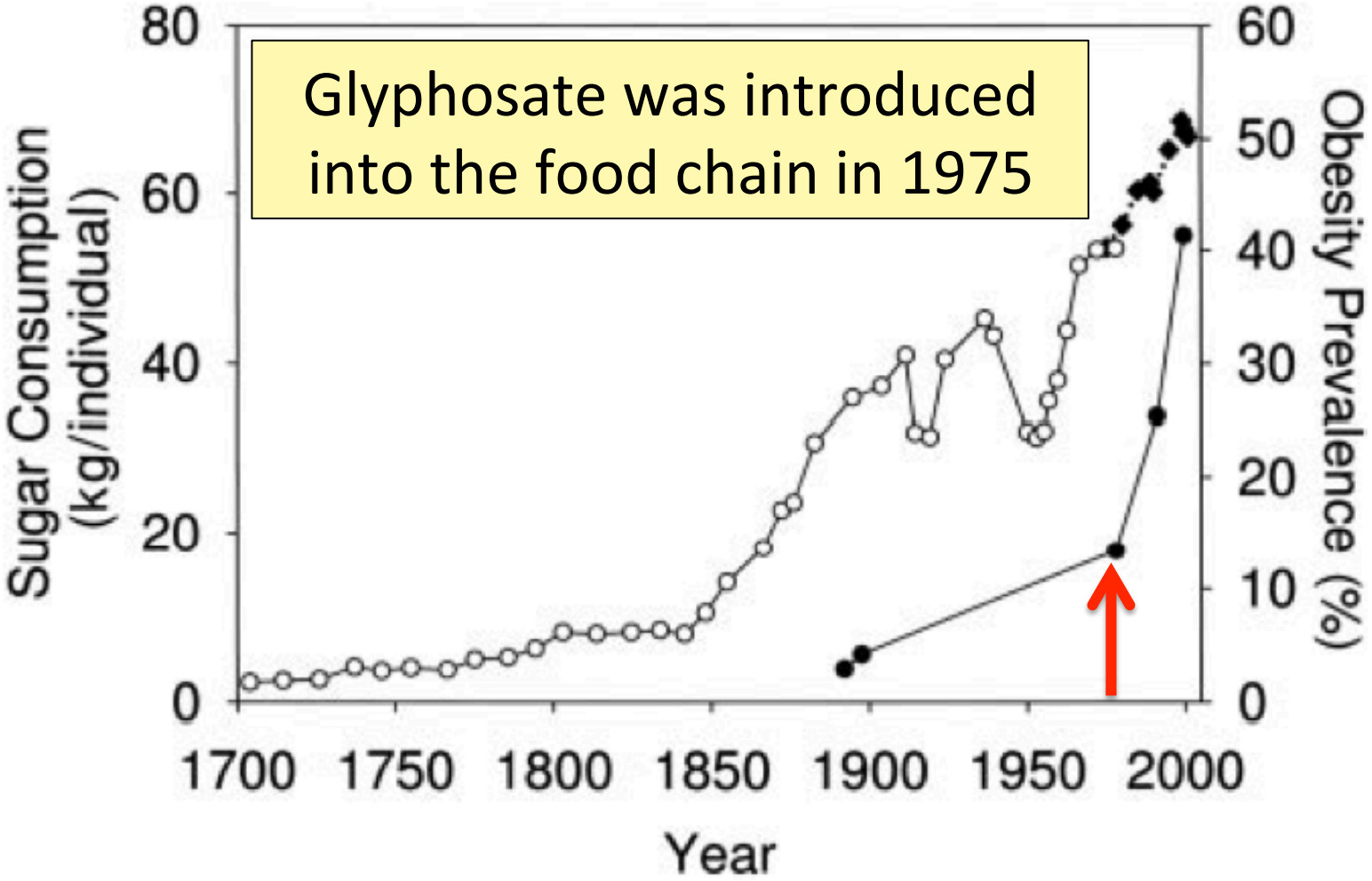


*Figure 1 in R.J. Johnson et al., Am J Clin Nutr 2007;86:899–906.

Pigs Fed GMOs Develop Inflamed Gut*

- Pigs have a similar digestive system to humans
- Digestive problems observed anecdotally in GMO-fed pigs
  - inflammation in stomach and intestine, stomach ulcers, thinning of intestinal walls, increase in haemorrhagic bowel disease

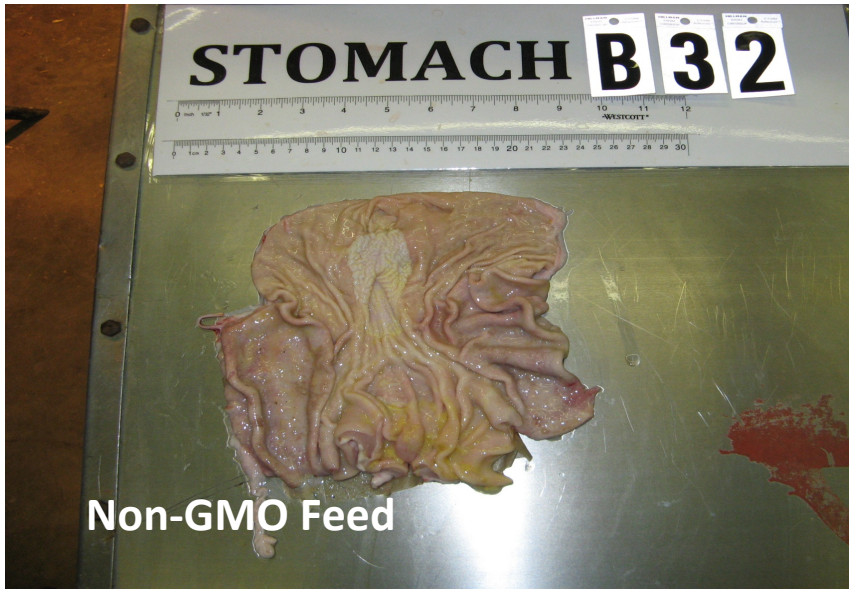
Follow-on Experiment:

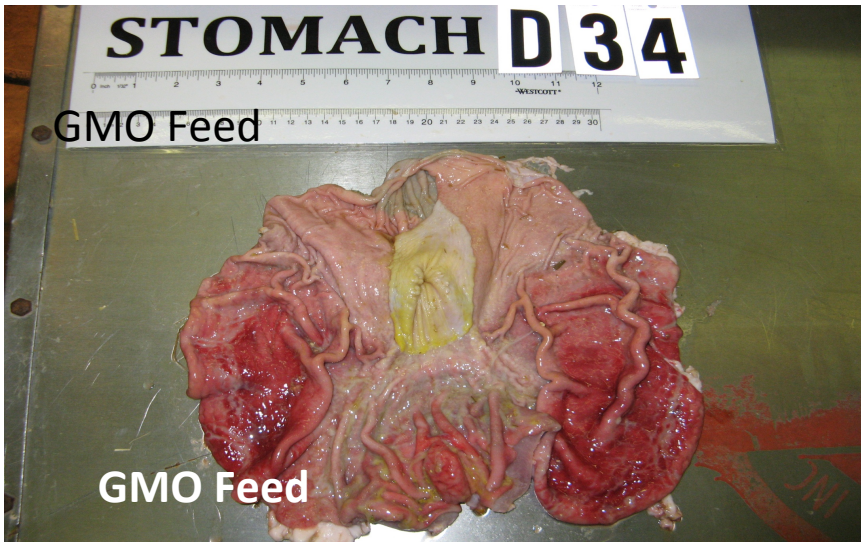
- 168 just-weaned pigs fed "typical diet," soy and corn, until slaughtered
  - Half fed GMO versions, half organic.

*J.A. Carman et al., Journal of Organic Systems, 8(1), 2013.

Pigs Fed GMOs Develop Inflamed Gut*

- Blind autopsies conducted
  - Female pigs' uterus 25% larger in GMO-fed pigs
  - Female pigs 2.2x more likely to get severe stomach inflammation on GMO diet
  - Males were 4x more likely





Photos kindly provided by Howard Vlieger

*J.A. Carman et al., *Journal of Organic Systems*, 8(1), 2013.

“Deformities, sickness and livestock deaths: the real cost of GM animal feed?”*

"When using GM feed I saw symptoms of bloat, stomach ulcers, high rates of diarrhoea, pigs born with the deformities ... but when I switched [to non GM feed] these problems went away, some within a matter of days.”

Quote from Ib Pedersen, producer of 13,000 pigs a year supplying Europe's largest pork company, Danish Crown

*Andrew Wasley, Nov. 28, 2013, The Ecologist., theecologist.org/News/news_analysis/2176082/deformities_sickness_and_livestock_deaths_the_real_cost_of_gm_animal_feed.html

America's Two-Headed Pig*

Treating Nutritional Deficiencies and Disease in a Genetically Modified, Antibiotic Resistant and Pesticide Dependent World

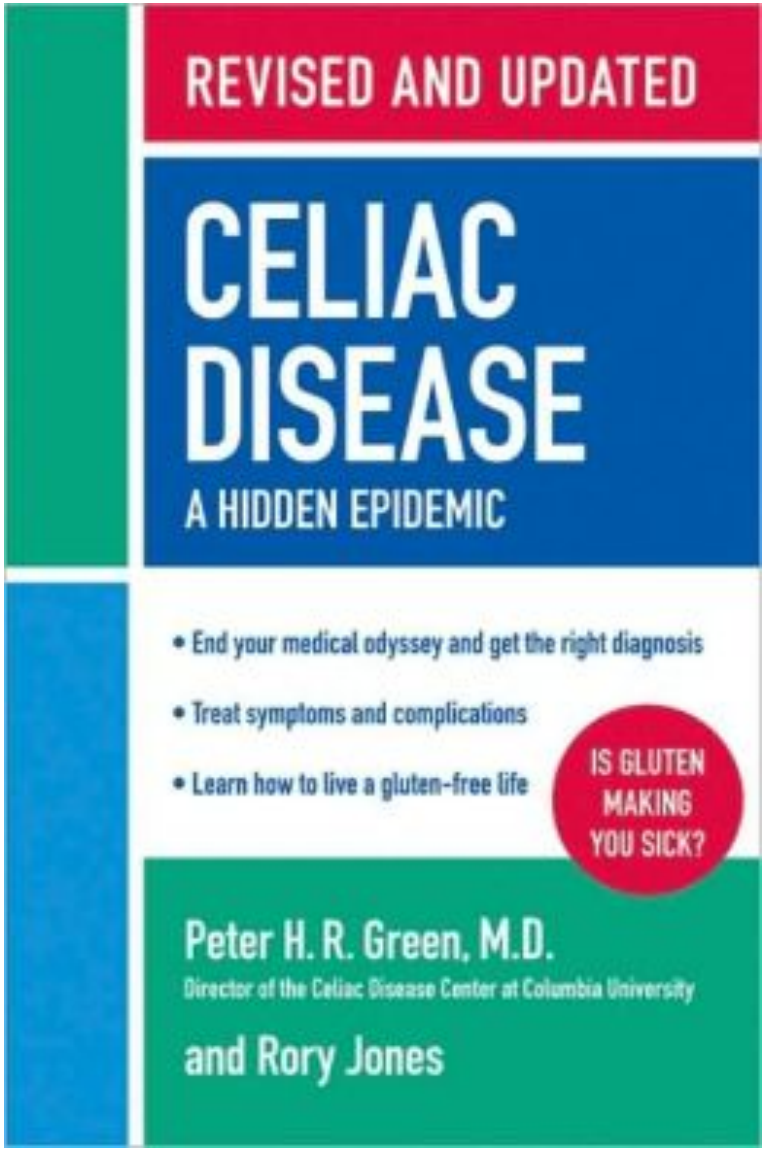
*book by Leah Dunham, www.americastwoheadedpig.com, 2013

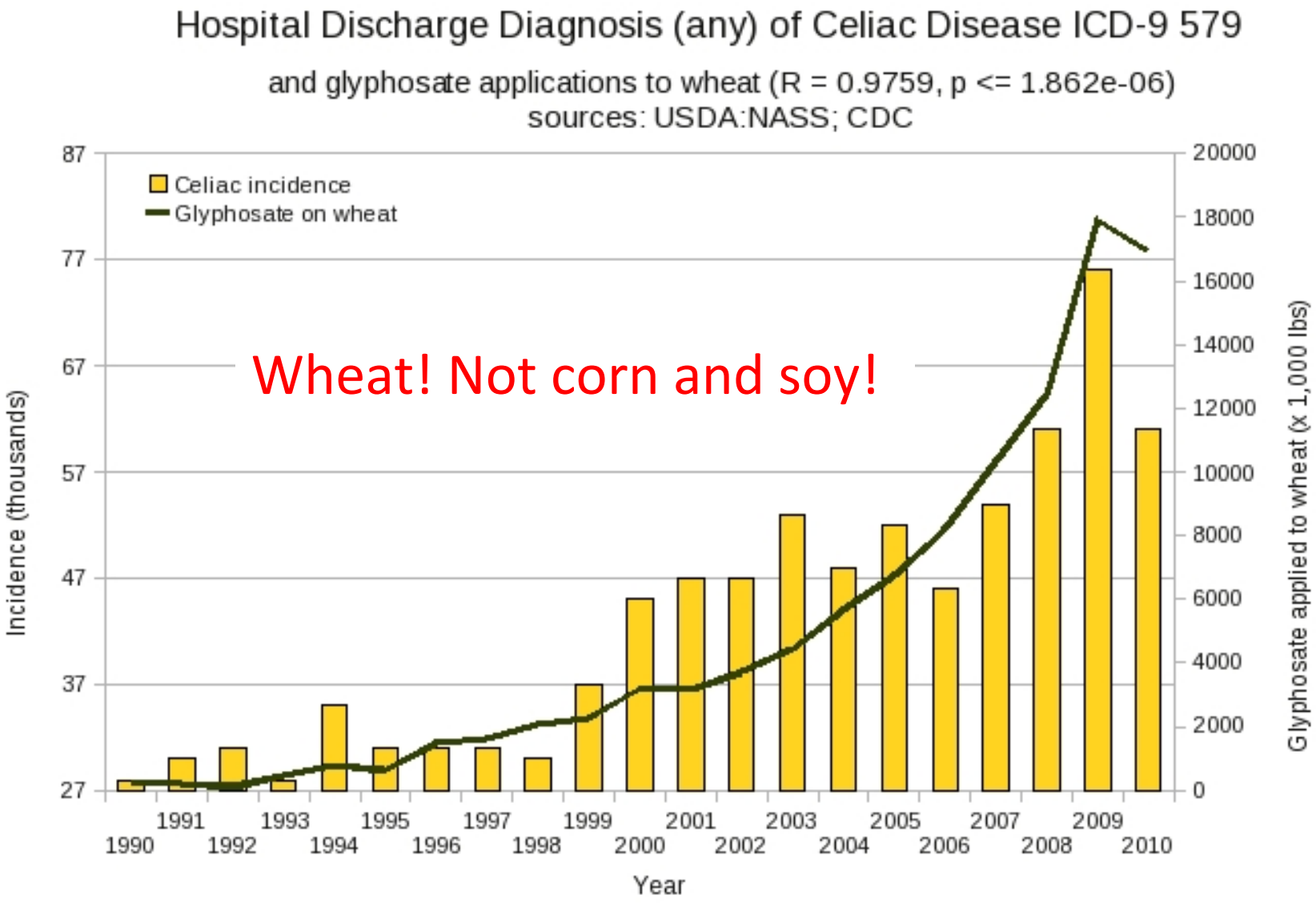
Human Digestive System Disorders

- Alarming increase in the US in many diseases related to the gut
  - Crohn's disease, inflammatory bowel disease, colitis, acid reflux disease, gluten and casein intolerance, celiac disease, leaky gut
- The gut-brain axis links neurological disorders with gut disorders
- I believe that glyphosate is a major cause


CHECK OUT
OUR NEW
GLUTEN
FREE
AISLE!

Celiac Disease has Quadrupled in the US in the Last 50 Years





Graph provided by Nancy Swanson, with permission

Why is glyphosate usage on wheat going up?

"Herbicide Resistant Ryegrass Troubling for Wheat Growers"*

"If you see ryegrass at harvest following an Axial XL application, it may be resistant. And you can scatter seed all over the field with the combine."

"A reduced-tillage approach, using a *burndown herbicide* ahead of planting in a stale seedbed, also holds promise for improved control."

" 'We may be able to knock out 80% to 90% of the resistant ryegrass with glyphosate.' "

-- Jim Swart, integrated pest management specialist

*Ron Smith, Western Farm Press, Mar. 23, 2013

Desiccation: It's Not Just Wheat

- Advantages:
  - Hastens maturity to harvest
  - Weed control for next year's crop
  - Reduces green material and therefore strain on harvesting machinery

- Disadvantages
  - Herbicide cannot be washed out prior to human use.
  - Animals fed herbicide-treated crops --> contamination in animal products
- Crops include wheat, barley, legumes, corn, sunflower, kiwi, grapes (wine), raspberries, apples, soybeans, alfalfa, sugar cane

Human Dietary Experiment on Wheat & Inflammatory Bowel Syndrome*

- Significant improvement in symptoms with dietary organic wheat from ancient source
  - Abdominal pain (P< 0.0001)
  - Bloating (P=0.004)
  - Stool consistency (P<0.001)
  - Tiredness (P< 0.0001)

- Reduced pro-inflammatory cytokines: IL-6, IL-17, interferon-gamma, VEGF

*F. Sofi et al., Br J Nutr. 2014 Feb 13:1-8. [Epub ahead of print]

Paper on Glyphosate and Celiac Disease

Interdiscip Toxicol. 2013; **Vol. 6**(4): 159–184.
doi: 10.2478/intox-2013-0026
Published online in:
www.intertox.sav.sk & www.versita.com/it

REVIEW ARTICLE

Glyphosate, pathways to modern diseases II: Celiac sprue and gluten intolerance

Anthony SAMSEL [1] and Stephanie SENEFF [2]

Celiac Disease, Glyphosate and Non-Hodgkin's Lymphoma

- Bifidobacteria are depleted in celiac disease*
  - They convert gluten to less toxic form
- Glyphosate preferentially kills bifidobacteria**
- Celiac disease is associated with increased risk to non-Hodgkin's lymphoma***
- Glyphosate itself is also linked directly to non-Hodgkin's lymphoma****

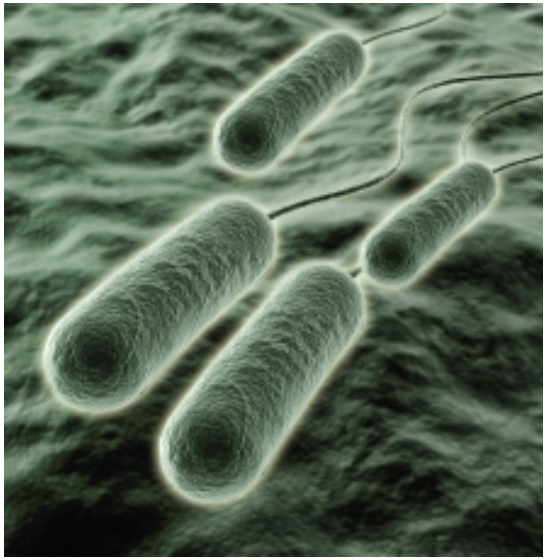
*M. Velasquez-Manoff, NY Times Sunday Review, Feb. 23, 2013

**A.A. Shehata et al., Curr Microbiol. 2013 Apr;66(4):350-8.

.*** C. Catassi et all, JAMA. 2002 Mar 20;287(11):1413-9.

****M. Eriksson et al., Int J Cancer. 2008 Oct 1;123(7):1657-63.

Pseudomonas and Glyphosate*



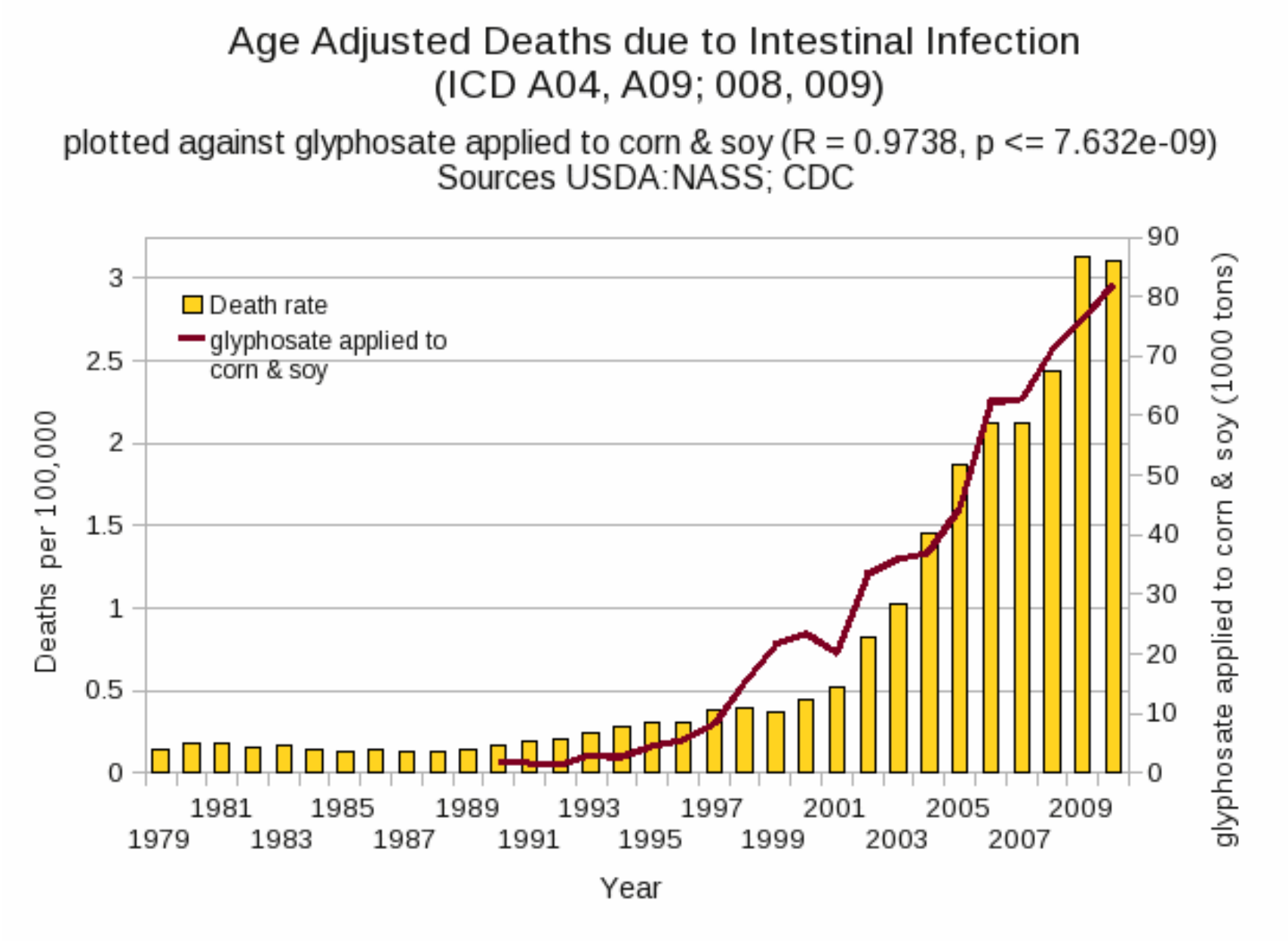
- Pseudomonas aeruginosa, a gram negative bacterium, is a major problem today in hospitals due to its resistance to multiple antibiotics
- P. aeruginosa is one of only three bacterial species that can break down glyphosate.
  - It produces formaldehyde as a by-product
  - Formaldehyde is a well established neurotoxin

*S. de Betnzmann and P. Plésiat Environ Microbiol. 2011 Jul;13(7):1655-65.

"Dramatic Increase in Hospitalization of US Children With Inflammatory Bowel Disease"*

- Study conducted at Case Western Reserve University School of Medicine
- > 11 Million hospitalization records examined
- Patients < 20 years old
  - 49% increase from 2000 to 2009 in Crohn's disease discharges
  - 71% increase in ulcerative colitis discharges

* Science Daily, June 25, 2013



*Plot prepared by Nancy Swanson from available data online

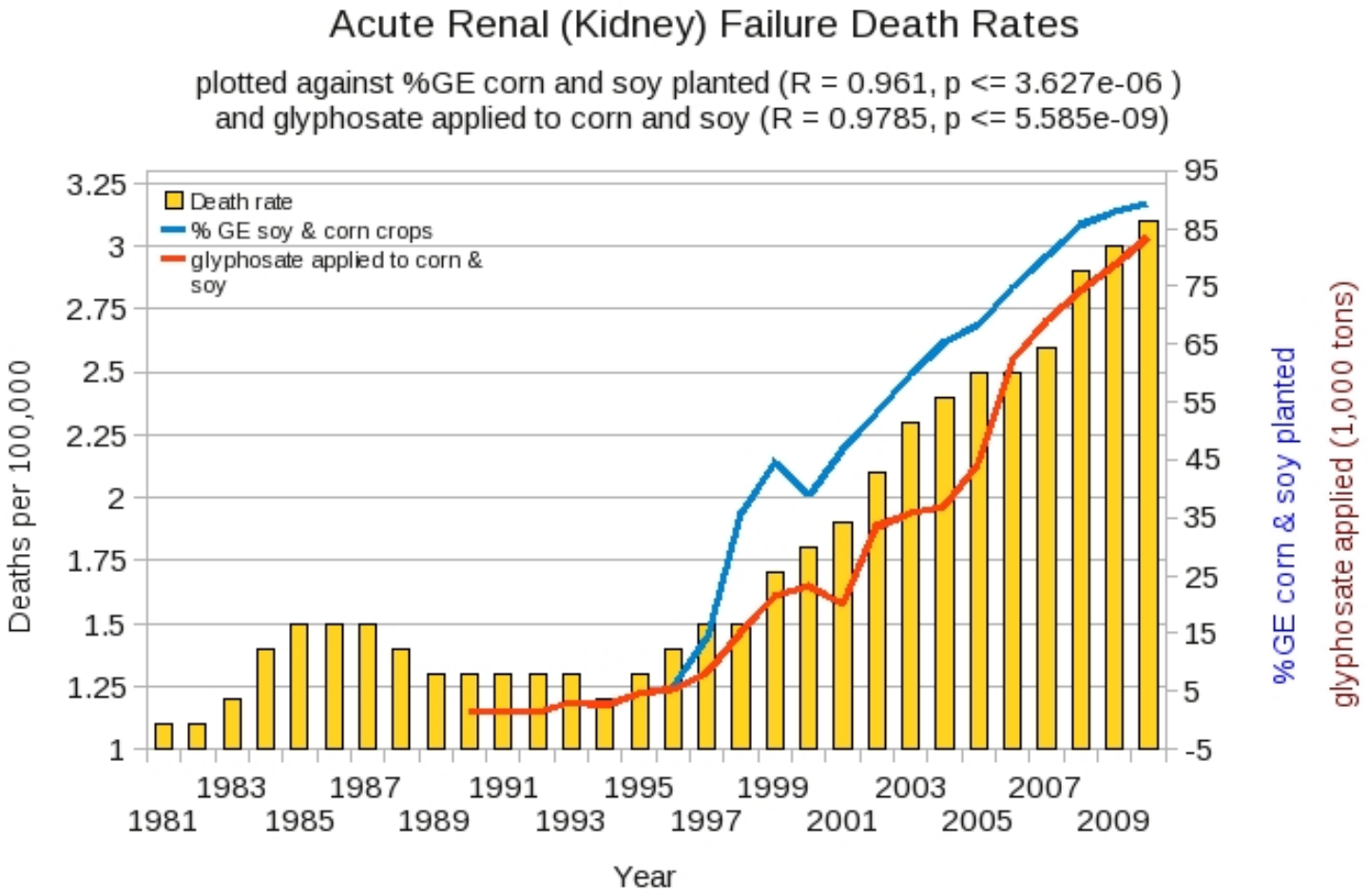
Kidney Failure in Agricultural Workers*

- Workers in sugarcane fields in Central America and in India are dying at a young age in record numbers from kidney failure
- Arsenic exposure from drinking water?
- Excess use of tylenol?

Glyphosate disrupts the enzyme that breaks down tylenol, leading to tylenol toxicity

*ticotimes.net, San Jose, Costa Rica, August 8, 2013.

Acute Kidney Disease Death Rate Plotted Against Glyphosate and GMOs*



*Plot prepared by Nancy Swanson from available data online

Int. J. Environ. Res. Public Health **2014**, *11*, 2125-2147; doi:10.3390/ijerph110202125

OPEN ACCESS

International Journal of
Environmental Research and
Public Health
ISSN 1660-4601
www.mdpi.com/journal/ijerph

Sri Lanka is the first
Country to Ban Glyphosate

Hypothesis

Glyphosate, Hard Water and Nephrotoxic Metals: Are They the Culprits Behind the Epidemic of Chronic Kidney Disease of Unknown Etiology in Sri Lanka?

arsenic

This is analogous to glyphosate's chelation of aluminum.
This problem did not exist in Sri Lanka prior to the 1990s.

Another Country Responds to Kidney Failure in Agricultural Workers!

Recapitulation

- We depend on our gut bacteria in many ways
  - Bacteria from an obese person induce obesity in mice
- Glyphosate is an antibiotic that preferentially kills the good bacteria
  - Pigs fed GMO corn and soy develop inflammatory gut
  - Humans are experiencing an epidemic in gut disorders like inflammatory bowel disease and gluten intolerance
  - Due to herbicide-resistant rye grass, farmers use glyphosate as a desiccant at harvest time
- Kidney failure among agricultural workers can be explained by glyphosate

Infertility and Birth Defects

Fertility Rates are Dropping Worldwide*

- Fertility rates are falling rapidly in countries around the world, often to below 2.0.
  - Cultural changes play a role
  - But glyphosate is likely contributing as well
- Sperm depend on cholesterol sulfate for decapitation and fertilization
- Cholesterol sulfate synthesis depends on cytochrome P450 (CYP) enzymes
- Glyphosate disrupts CYP enzyme function

*A. Samsel and S. Seneff, Entropy 2013, 15, 1416-1463.

"Male fertility under threat as average sperm counts drop"*

- Study of 26,600 men in France found sperm concentration had decreased by 32% since the 1990s.
- Numbers steadily dropped by 2% per year from 1989 to 2005.
- Proportion of normally formed sperm also declined by about 1/3.

* M. Rolland et al., Hum Reprod. 2013 Feb;28(2):462-70.

This Defect Likely Transfers to Subsequent Generations*

- Designer mice (obesity gene) fed a diet mimicking fast food diet
- This initiated subfertility in both male and female offspring lasting over two generations
- Suggest altering of epigenome of sperm, leading to developmental programming of subfertility outcome

*T. Fullston et al., Human Reproduction 27(5), 1391-1400, 2012.

Roundup and birth defects: Is the public being kept in the dark?*

"Our examination of the evidence leads us to the conclusion that the current approval of glyphosate and Roundup is deeply flawed and unreliable. …. We show that industry and regulators knew as long ago as the 1980s and 1990s that glyphosate causes malformation – but that this information was not made public."

**Michael Antoniou et al., Earth Open Source, June, 2011*

Glyphosate and Anencephaly*

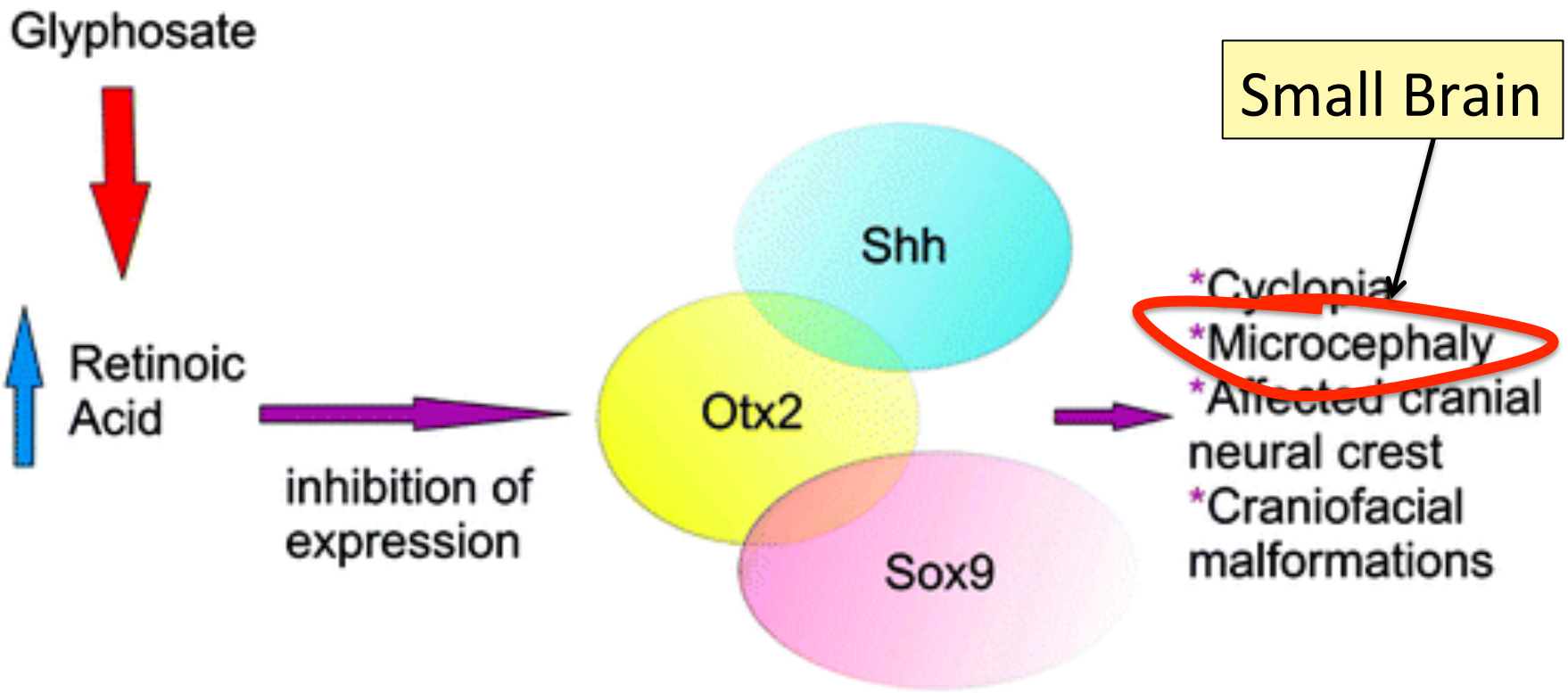
- Yakima, Benton and Franklin counties in Washington State have an unusually high number of pregnancies affected by the birth defect, anencephaly
- 75 pesticides were analyzed in studying contamination due to surrounding agriculture
  - 47 (63%) of these were detected
  - Glyphosate was applied in large amounts, but was not studied

- 5% solution of glyphosate was also used heavily around irrigation ditches to control weeds
  - Main herbicide recommended due to its "low toxicity"

Glyphosate has been linked to anencephaly due to its effect on retinoic acid

*__Barbara H. Peterson__. __Farm Wars__, http://farmwars.info/?p=11137

Glyphosate Upregulates Retinoic Acid*



*A. Carrasco, Teratogenesis by glyphosate based herbicides and other pesticides. Relationship with the retinoic acid pathway. In Breckling, B. & Verhoeven, R. (2013) GM-Crop Cultivation – Ecological Effects on a Landscape Scale. Theorie in der Ökologie 17. Frankfurt, Peter Lang.

Article on GM Soy Imports in China*

"The Zhengzhou Daily News reported on April 2, 2013: The number of children confirmed with autism has increased 100 times during the past 20 years"

- Infertility rates: 15.6% 2012; 8% 2002; 3% 1972.
- Parkinson's disease in China has increased over 20 fold during the last 20 years

*http://blog.sina.com.cn/s/blog_502041670102em9z.html
former Vice President of the Academy of Military Science of China

Glyphosate chelates manganese!

"The mechanism by which glyphosate disrupts the EPSPS enzyme in plants and microorganism is by chelating the *manganese* metal co-factor of this enzyme. In other words it steals the 'ignition key' of the enzyme."

Dr. Arden Andersen, D.O.,

Food Plague Primer: Glyphosate and Genetically Engineered Crops

"Fundamentally **the herbicidal effect of glyphosate is ultimately due to soil pathogens** gaining access to the "weed" thanks to glyphosate's weakening of the plant and killing of beneficial microbes *by the chelation of manganese* and other trace elements."

Dr. Arden Andersen, D.O.,

Food Plague Primer: Glyphosate and Genetically Engineered Crops

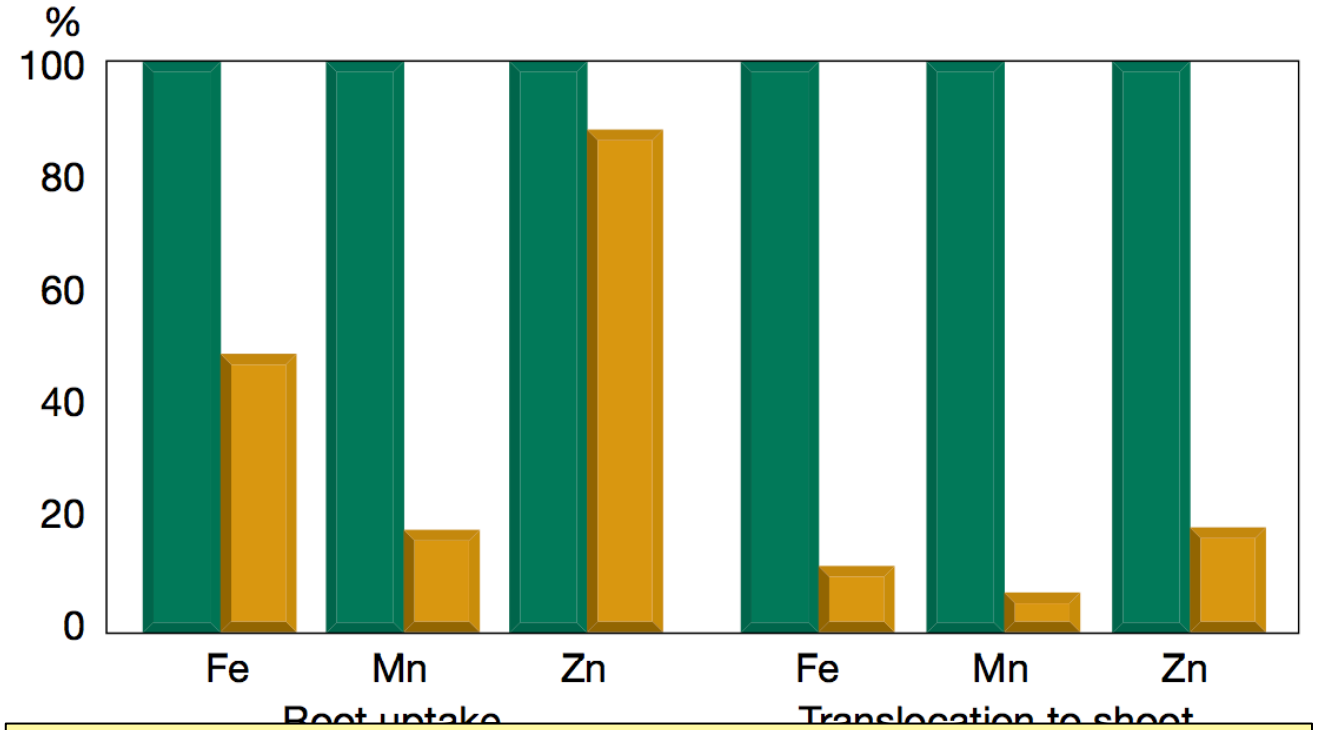
"Fu **is u** to t the *che*

This is analogous to glyphosate's effect on gut bacteria: killing the beneficial bacteria and allowing the pathogens to overgrow

Dr. Arden Andersen, D.O.,

Food Plague Primer: Glyphosate and Genetically Engineered Crops

Glyphosate Depletes Iron, Manganese and Zinc in Plants*

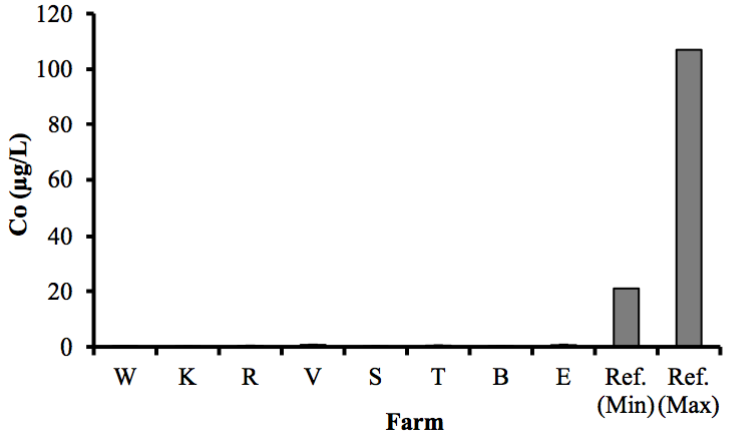


Manganese uptake is already drastically reduced in the root

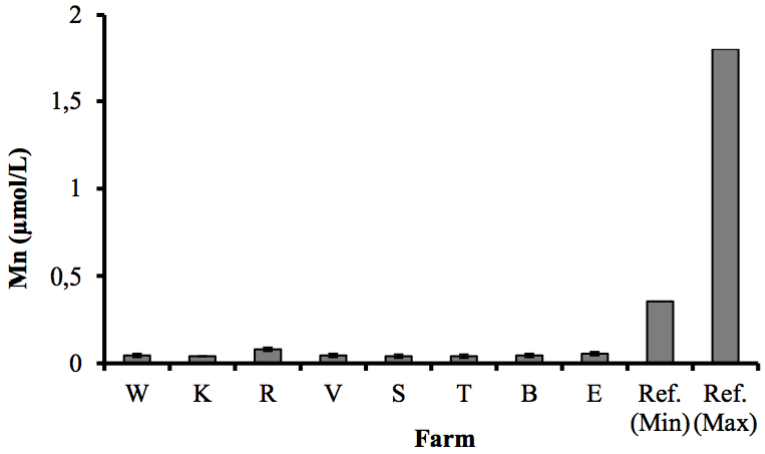
*D Huber, **What About Glyphosate-Induced Manganese Deficiency?** Fluid Journal, 20-22.

Severe Deficiency in Serum Manganese and Cobalt in Cows Fed GMO Roundup-Ready Corn and Soy*

Cobalt



Manganese

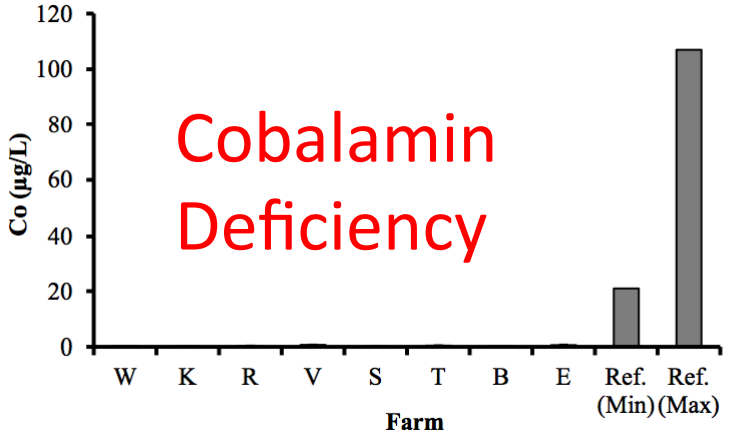


Eight different farms: all cows tested had glyphosate in the urine

*M. Krüger et al., J Environ Anal Toxicol 2013, 3:5

Severe Deficiency in Serum Manganese and Cobalt in Cows Fed GMO Roundup-Ready Corn and Soy*

Cobalt



Manganese

Eight different farms: all cows tested had glyphosate in the urine

*M. Krüger et al., J Environ Anal Toxicol 2013, 3:5

Manganese Deficiency: Lactobacillus and Anxiety

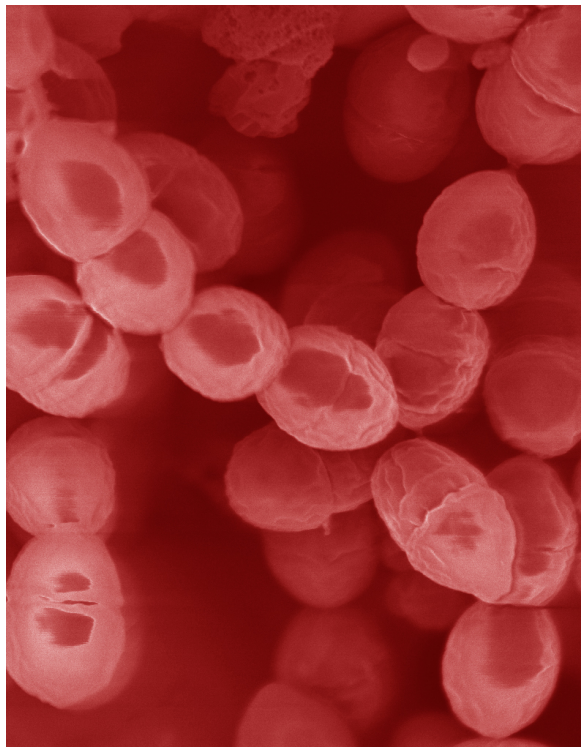
Glyphosate Kills Beneficial Bacteria*

- Examined effect of glyphosate and Roundup on three food microorganisms widely used as starters in dairy technologies
  - Two are species of *Lactobacillus*
- Roundup is always more potent than glyphosate, and in all cases, toxic from levels 10–100 times below the lowest agricultural uses (10,000 ppm).
- Unpredictable consequences of Roundup on soil microorganisms have to be considered

*E Clair et al. Curr Microbiol (2012) 64:486–491

Lactobacillus Depends on Manganese!*

- Many lactic acid bacteria contain very high intracellular manganese levels
  - Scavenges toxic oxygen species, particularly superoxide
- Manganese deprivation suppresses growth

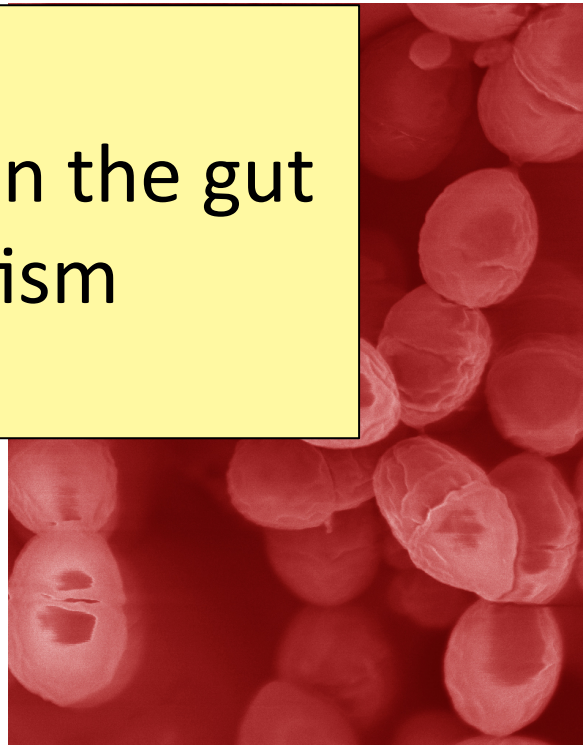


* FS Archibald and M-N Duong. Journal of Bacteriology Apr 1084, 1-8.

Lactobacillus Depends on Manganese!*

- Many lactic acid bacteria contain very high intracellular manganese level
  - Sc
    pa
- Man
  suppresses growth

Lactobacillus levels are low in the gut in association with autism



* FS Archibald and M-N Duong. Journal of Bacteriology Apr 1084, 1-8.

Lactobacillus Alleviate Anxiety*

- Patients suffered from chronic fatigue syndrome and associated anxiety
- Patients were treated with probiotic strain of Lactobacillus (control group got a placebo)
- Significant rise in both Latobacillus and Bifidobacteria in gut
- Significant decrease in anxiety symptoms ($p = 0.01$)
- Supports concept of gut-brain axis (communicate with brain via vagal nerve)

*R Av et al. Gut Pathog. 2009 Mar 19;1(1):6. doi: 10.1186/1757-4749-1-6.

Lactobacillus Alleviate Anxiety*

- Patients suffered from chronic fatigue syndrome and associated anxiety
- [illegible]
- [illegible] Bifidobacteria in gut
- Significant decrease in anxiety symptoms ($p = 0.01$)
- Supports concept of gut-brain axis (communicate with brain via vagal nerve)

Increased anxiety is a comorbidity of autism

*R Av et al. Gut Pathog. 2009 Mar 19;1(1):6. doi: 10.1186/1757-4749-1-6.

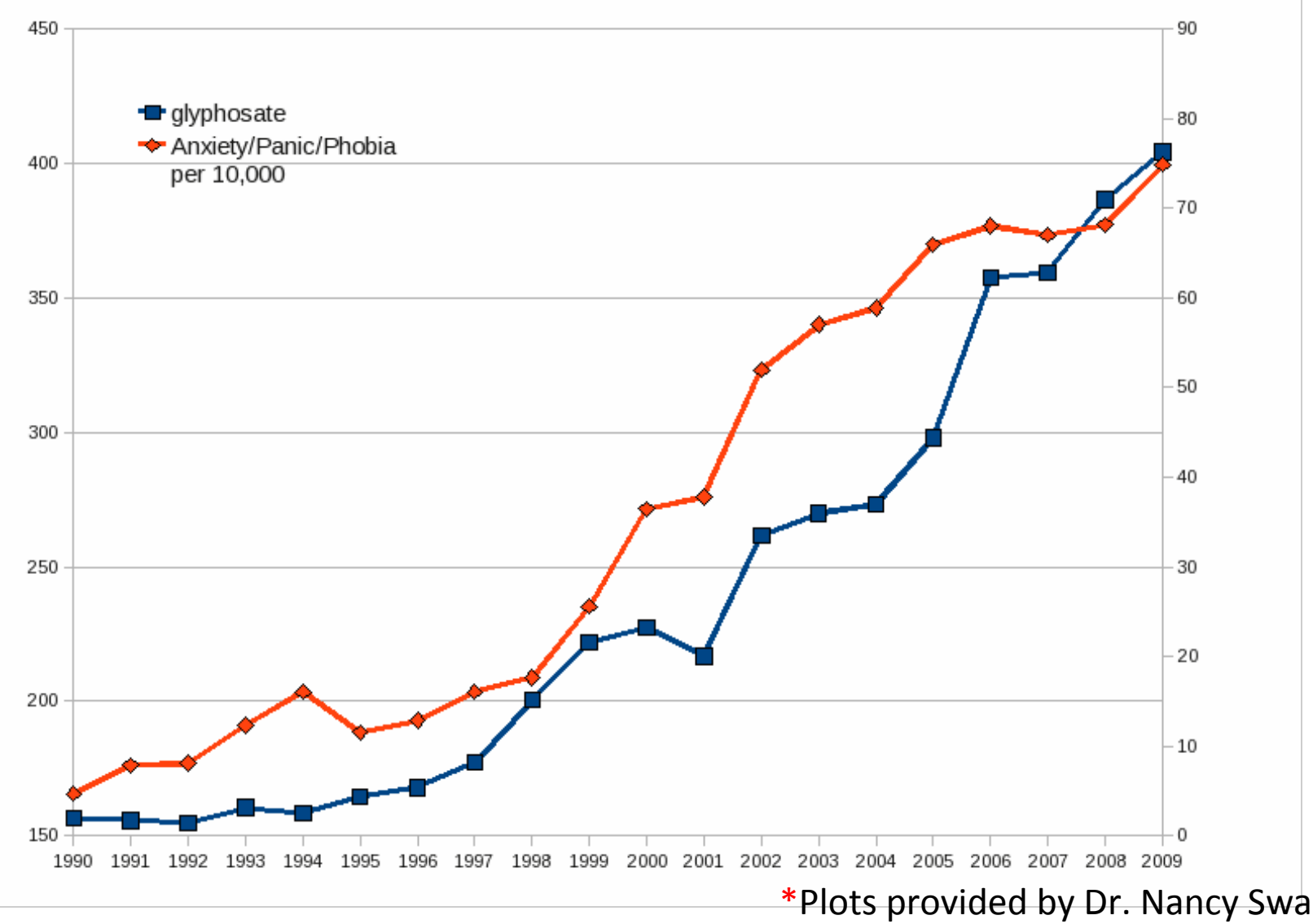
Anxiety and Autism*

Children with autism suffer from many forms of anxiety disorder in higher numbers than the general population

Specific Phobia	30%
Obsessive-Compulsive Disorder	17%
Social Anxiety Disorder/Agoraphobia	17%
Generalized Anxiety Disorder	15%
Separation Anxiety Disorder	9%
Panic Disorder	2%

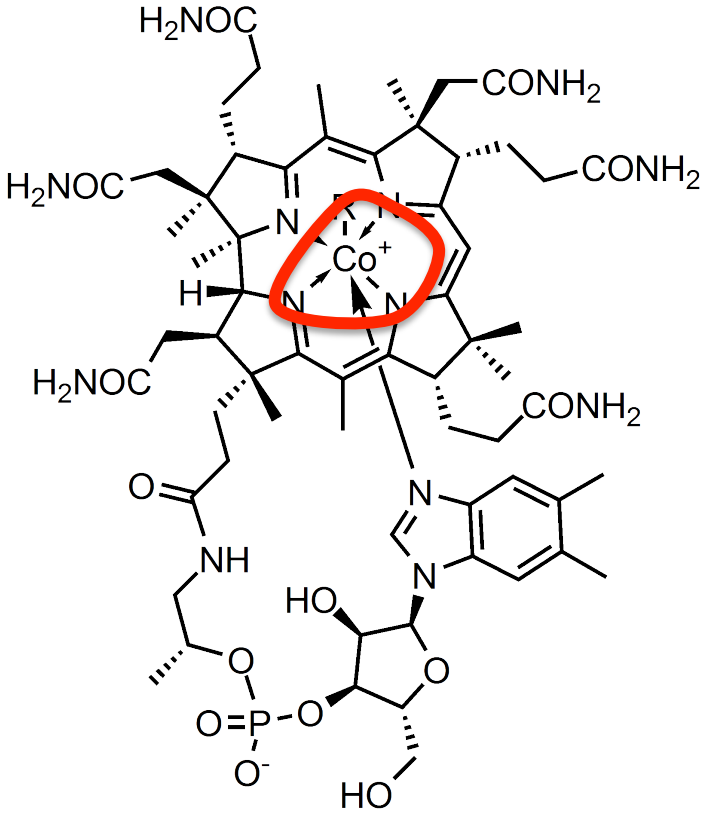
*Van Steensel, F.J.A., Bogels, S.M., & Perrin, S. (2011). Anxiety disorders in children and adolescents with autistic spectrum disorders: A meta-analysis. Clinical Child and Family Psychology Review, 14, 302-317.

Glyphosate Application on Corn and Soy Plotted against Anxiety, Panic Disorder and Phobias*

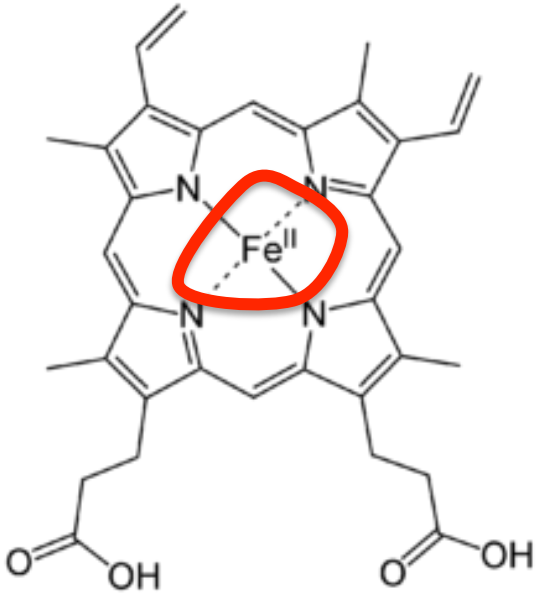


*Plots provided by Dr. Nancy Swanson

Bacteria Incorporate Cobalt and Iron into Cobalamin and Heme

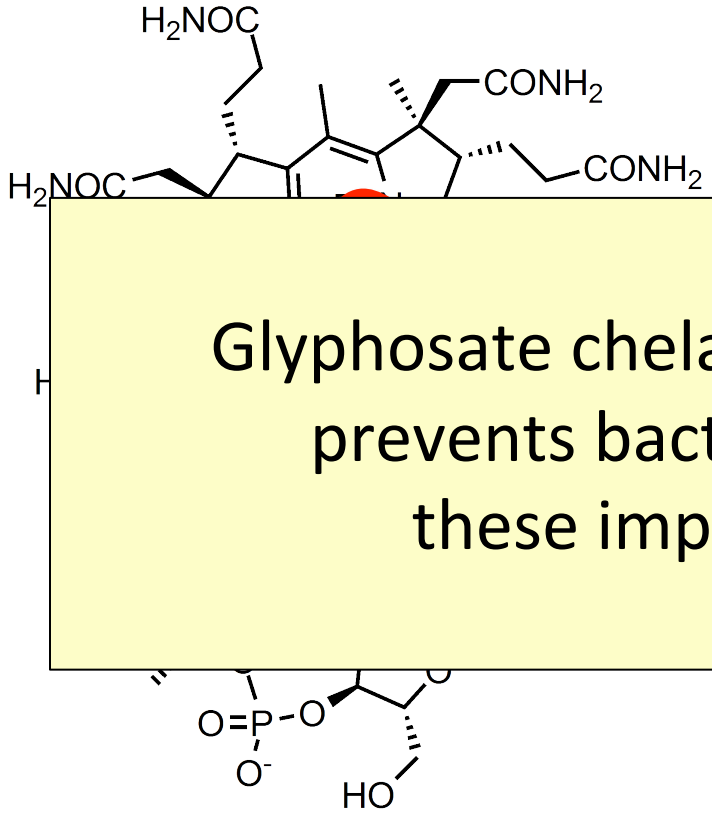


Cobalamin

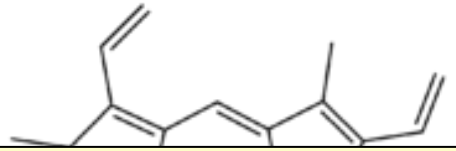


Heme Iron

Bacteria Incorporate Cobalt and Iron into Cobalamin and Heme



Cobalamin



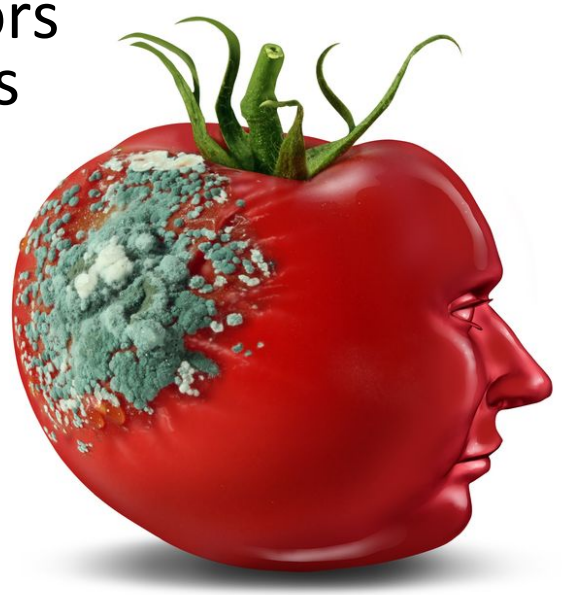
Heme Iron

Glyphosate chelates cobalt and iron and prevents bacteria from producing these important molecules

Manganese Deficiency: Glutamate and Ammonia

Glyphosate and Glutamate*

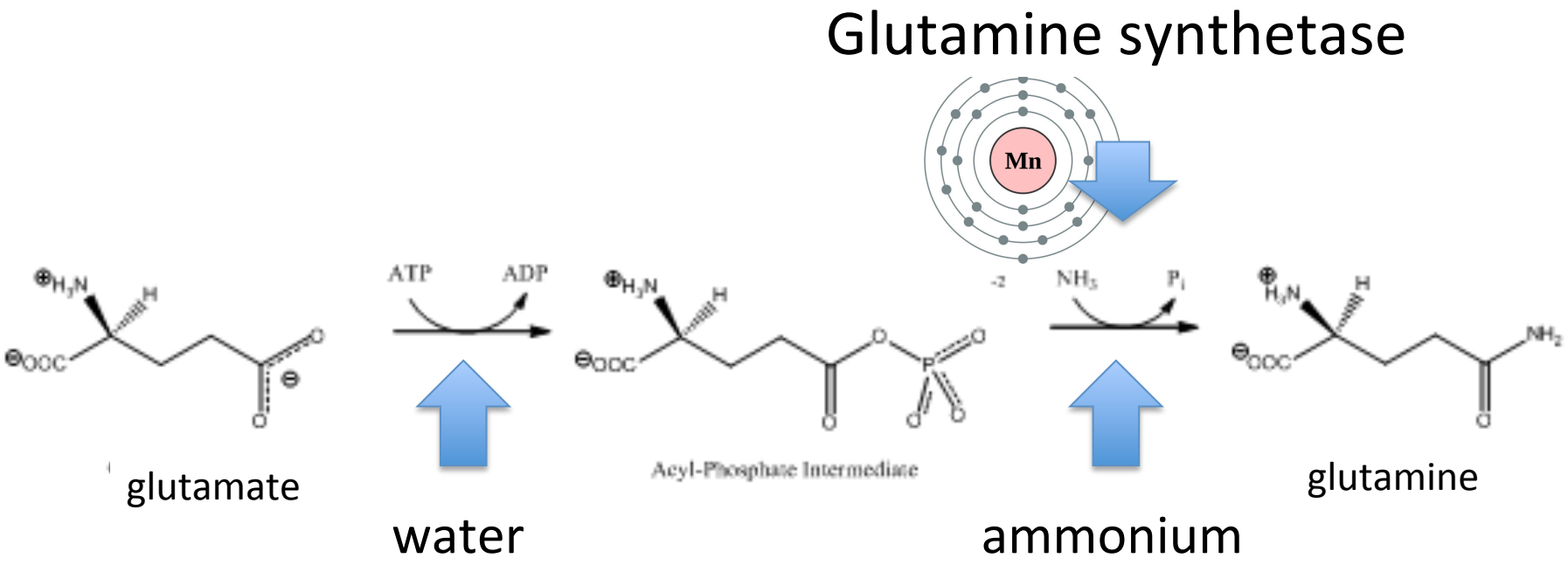
- Acute exposure activates NMDA receptors and voltage-dependent calcium channels
  - Oxidative stress and neural cell death
  - Increased glutamate released into the synaptic cleft → *excessive extracellular glutamate levels*
  - Decreased glutathione content
  - Increased peroxidation of lipids (fats)



- Chronic exposure:
  - Decreased glutamate uptake and metabolism
  - Induced calcium uptake
  - Induced oxidative stress

*http://www.greenmedinfo.com/blog/roundup-weedkiller-brain-damaging-neurotoxin

Glutamine Synthesis Depends on Manganese!



Ammonium and glutamate toxicity in the brain can arise because of insufficient manganese

"Alteration of Plasma Glutamate and Glutamine Levels in Children with High-Functioning Autism"*

Amino acid	Control	HFA	*p*-value
Alanine	326.1±61.6	300.3±55.0	0.145
α-Aminobutyric acid	18.8±3.8	18.7±5.4	0.971
Arginine	89.1±19.0	95.3±18.5	0.279
Asparagine	40.8±8.3	43.1±7.0	0.311
Glutamate	20.9±4.5	27.9±7.4	<0.002*
Glutamine	513.1±48.5	445.8±50.6	<0.0004**
Isoleucine	53.6±11.5	62.2±14.5	0.033
Leucine	99.0±16.1	106.4±22.4	0.210
Lysine	155.3±28.5	164.2±32.5	0.332
Methionine	23.7±5.1	25.8±5.6	0.203
Ornithine	43.9±11.3	51.9±10.8	0.021
Phenylalanine	51.7±6.8	55.1±8.4	0.146
Proline	153.7±56.4	131.7±47.6	0.165
Serine	105.4±15.6	115.8±14.7	0.027
Taurine	33.4±5.5	37.8±7.9	0.036
Threonine	100.8±19.7	112.0±24.3	0.097
Tryptophan	44.8±5.6	47.3±6.4	0.167
Tyrosine	60.9±10.5	58.4±10.1	0.425
Urea	3976.3±818.7	3759.9±773.3	0.367
Valine	200.2±29.4	217.1±29.7	0.062

P-value

*C. Shimmura et al. PLoSone October 2011 6(1):e25340

"Alteration of Plasma Glutamate and Glutamine Levels in Children with High-Functioning Autism"*

Of all the proteins measured, only glutamate and glutamine were abnormal

Glutamate	20.9±4.5	27.9±7.4	<0.002*
Glutamine	513.1±48.5	445.8±50.6	<0.0004**
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Journal of Personal Science: One Child's Autism Eliminated by Removal of Glutamate From Her Diet*
By Katherine Reid

First Round:

- Kale, cucumber, cilantro, nuts, seeds, fruits
- Magnesium B-complex, vitamin D3, omega 3 fats (EPA, DHA)
- Probiotics
- Gluten free and casein free (no wheat, no milk)

Child improved significantly but still had autistic behaviors

Second Round:

- ADD: ELIMINATE FREE GLUTAMATE

Child lost the "autism" label!

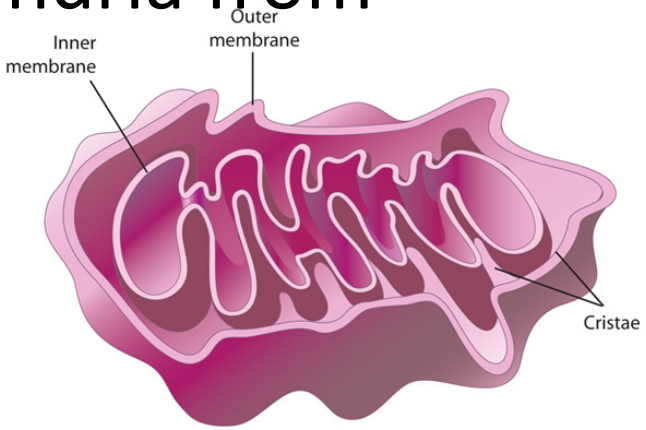
*blog.sethroberts.net/2013/05/17/journal-of-personal-science-one-childs-autism-eliminated-by-removal-of-glutamate-from-her-diet

Manganese Deficiency: Mitochondrial Disorder

Autism and Mitochondrial Disorder*

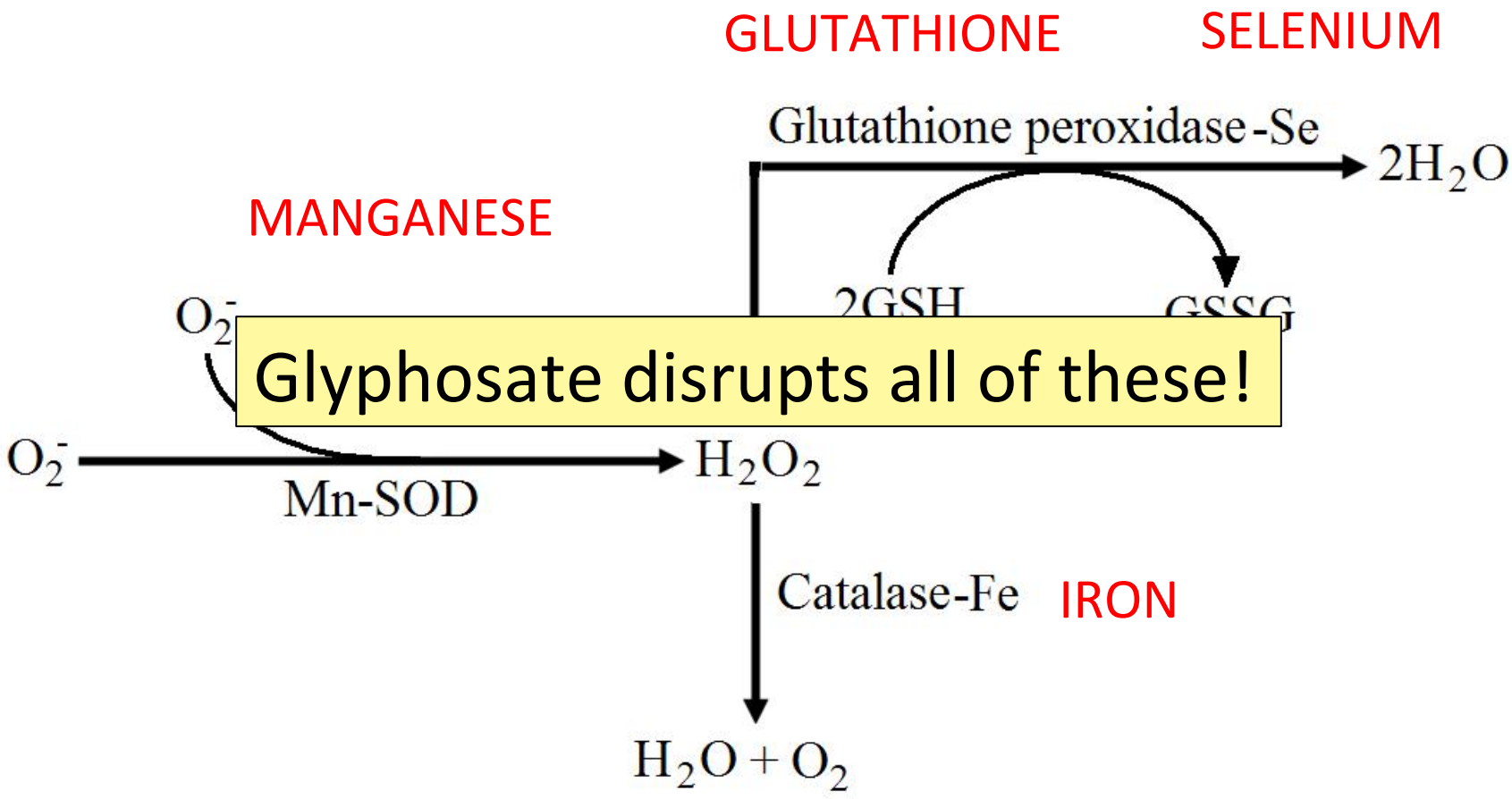
"Five of 11 patients studied were classified with definite mitochondrial respiratory chain disorder, suggesting that this might be one of the most common disorders associated with autism"

Manganese superoxide dismutase plays a critical role in protecting mitochondria from oxidative damage

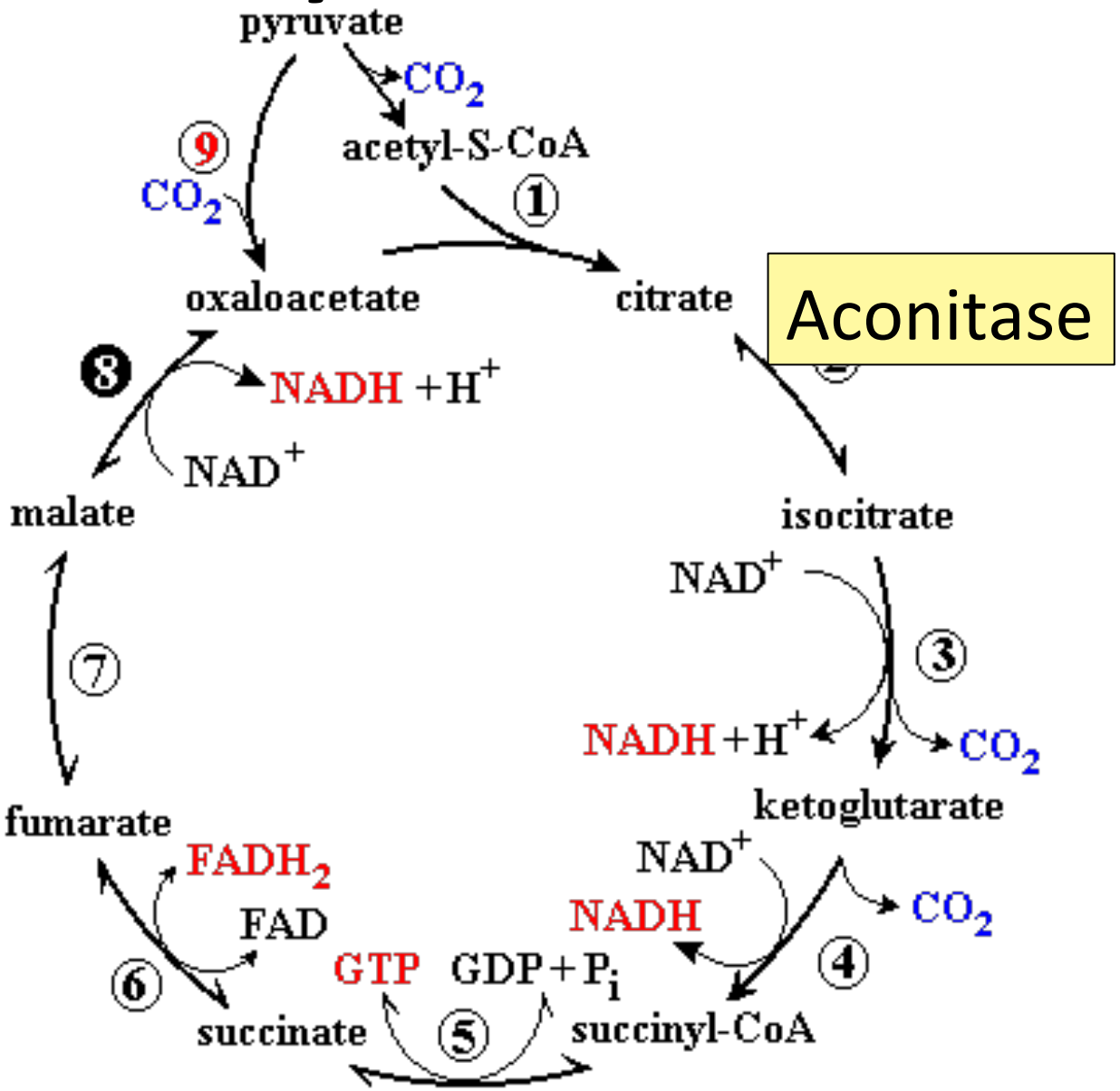


*G Oliveira et al. Developmental Medicine & Child Neurology 47(3), 185-189, 2005.

Detoxification of Superoxide (O_2^-)



Citric Acid Cycle in Mitochondria



*PR Gardner. Methods in Enzymology 349:9–23.

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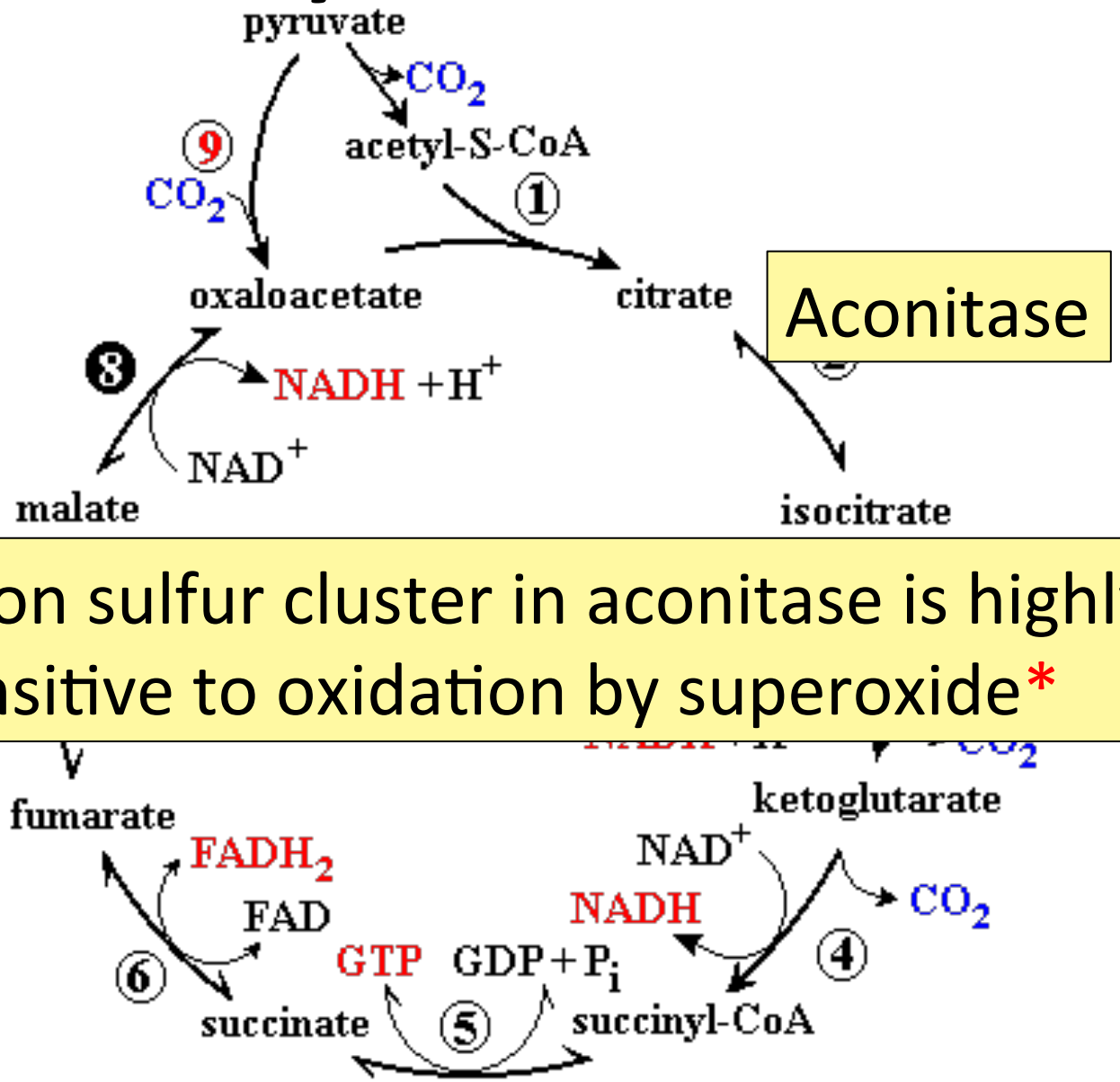
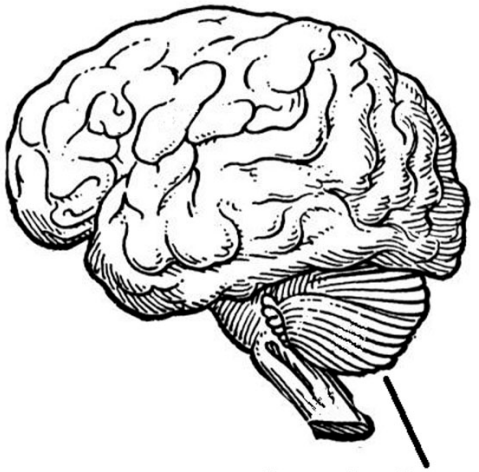


The iron sulfur cluster in aconitase is highly sensitive to oxidation by superoxide*

*PR Gardner. Methods in Enzymology 349:9–23.

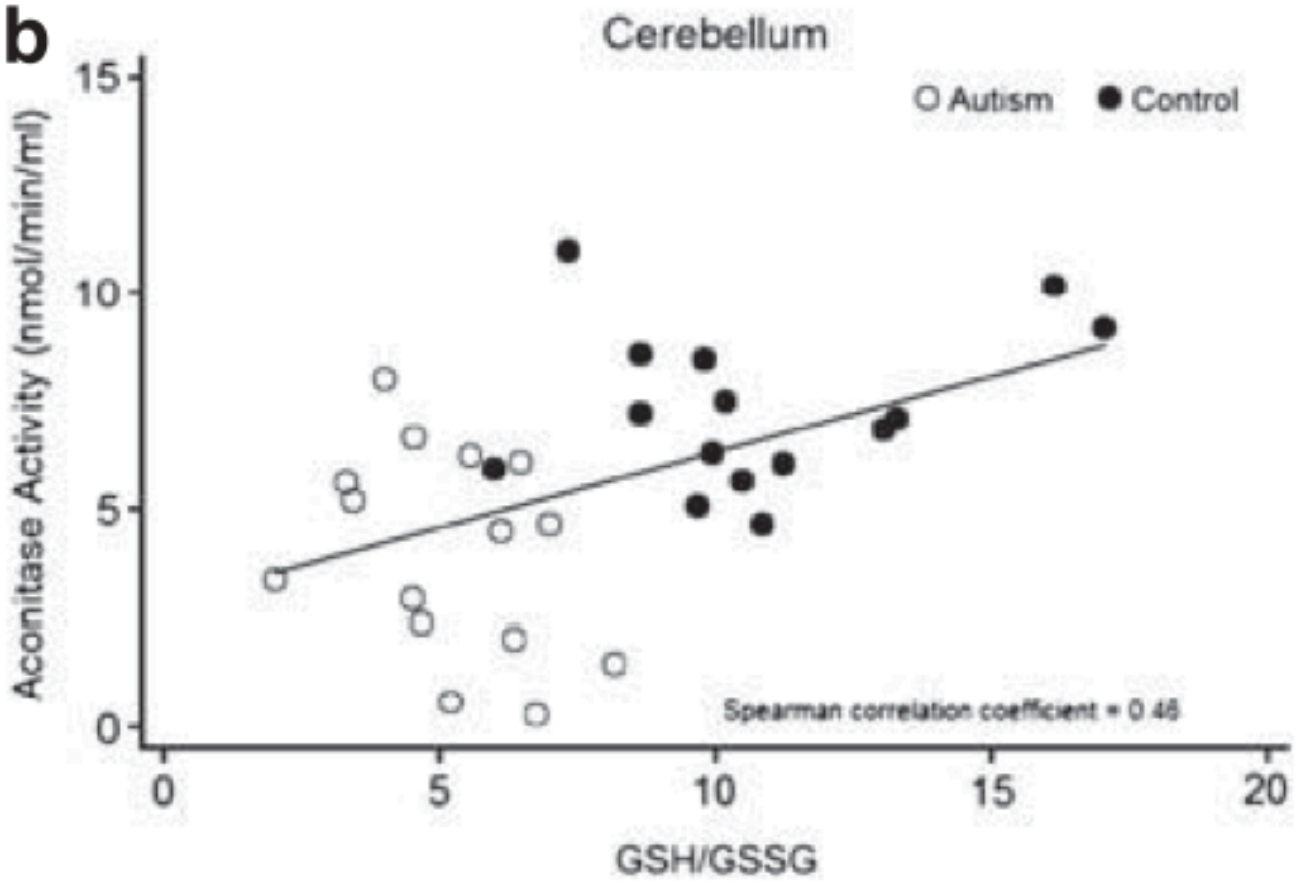
Aconitase Dysfunction and Brain Inflammation in Autism*

- Frozen samples of post-mortem tissues from cerebellum and temporal cortex of autism patients compared with controls.
- Compared to controls:
  - Aconitase activity was significantly reduced in the cerebellum and correlated with low glutathione levels
  - Biomorkers of inflammation were increased



*S. Rose et al. Transl Psychiatry (2012) 2:e134.

Aconitase & Glutathione in Cerebellum in Autism*



* S Rose et al. Transl Psychiatry (2012) 2:e134.

Manganese Deficiency: Impaired Bone development

Glyphosate and Bone Development*

- Dams treated with glyphosate in water from days 6 to 15 of their pregnancy
- Effects on pups:
  - Lack of development of the ossification centers of the terminal phalanges (bones in fingers and toes)
  - Larger fontanelles ("soft spot") and incomplete development of skull bones
  - Absence of important bones or parts of bones, shortenings, bendings, asymmetry, fusions or clefts.
  - Surfactant polyoxyethyleneamine increased glyphosate's toxicity

*E. Dallegrave et al. Toxicology Letters 142 (2003) 45-52.

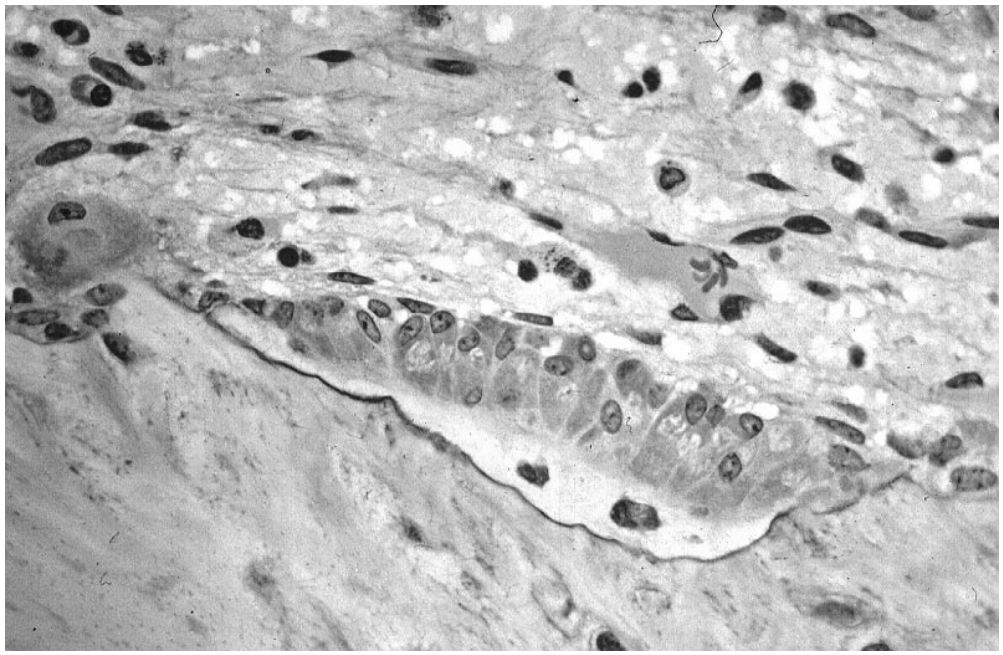
Manganese and Bones*

"The multiple cellular effects of Mn deficiency include: decreased bone resorption, production of labile bone, and *decreased synthesis of organic matrix.* The serum level of Mn in a group of osteoporotic postmenopausal women was significantly lower than age-matched controls."

*L. Strause and P. Saltman. Role of Manganese in Bone Metabolism. Chapter 5, pp 46–55 in Nutritional Bioavailability of Manganese.

Osteoblasts build "Ground Substance"

- Ground substance is made of chondroitin sulfate and osteocalcin – collagen is layered over this
- Poor mineralization results from impaired chondroitin sulfate synthesis



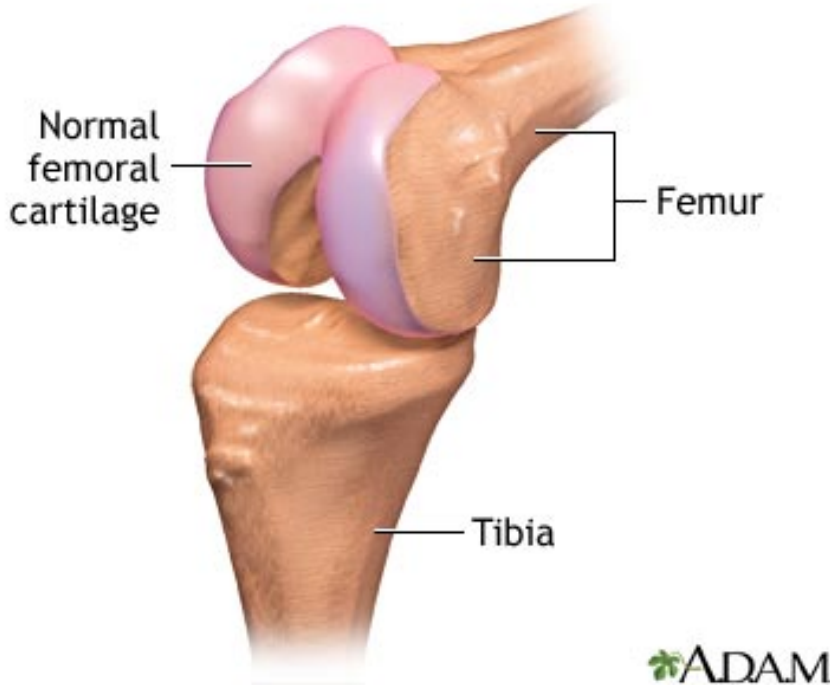
Osteoblasts in bone

Childhood osteoarthritis and osteomalacia are an epidemic in the US today

Chondroitin Sulfate Synthesis in Cartilage depends on Manganese*

Two critical enzymes are manganese dependent:

One forms the sugar chain and the other one links the sugar chain to the protein associated with it



*RM Leach et al. Archives of Biochemistry and Biophysics 133(1), 1969, 22-28.

Perineuronal Nets*

- Perineuronal nets (PNs) formed from *chondroitin sulfate* attached to hyaluronan, modulate GABAergic inhibitory signaling
- Removal of PNs increased excitability of interneurons in cultures
- They provide an environment rich in anions (negative charge)

*G. Bruckner et al. Glia 8(3), 183-200, 1993.

Perineuronal Nets*

- Perineuronal nets (PNs) formed from *chondroitin sulfate* attached to hyaluronan, mo
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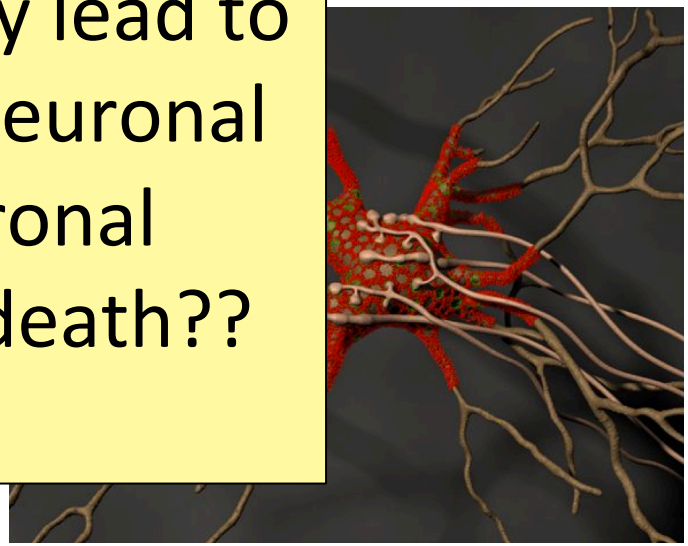
Might manganese deficiency lead to impaired synthesis of perineuronal nets and increased neuronal excitability leading to cell death??



*G. Bruckner et al. Glia 8(3), 183-200, 1993.

Coral Die-Off & Chondroitin Sulfate*

- Large amounts of chondroitin sulfate are adsorbed onto coral
- Sulfate groups are of paramount importance to the adsorption process
- Adsorption rate is a direct function of the amount of negative charge

*N. Volpi. Biomaterials 2002 Jul;23(14):3015-22.

“Disease Causes Starfish to Lose Arms, Dissolve into White Blobs of Goo” *

- Glyphosate is used to kill seagrass in oyster beds
- "Glyphosate and diuron are among the most frequently detected herbicides in oyster production areas"**
- Starfish eat oysters

*http://natureworldnews.com/articles/4749/20131104/disease-causes-starfish-lose-arms-dissolve-white-blobs-goo-video.htm

**F. Akcha et al. Aquatic Toxicology. 106-107 (pp 104-113), 2012

Recapitulation

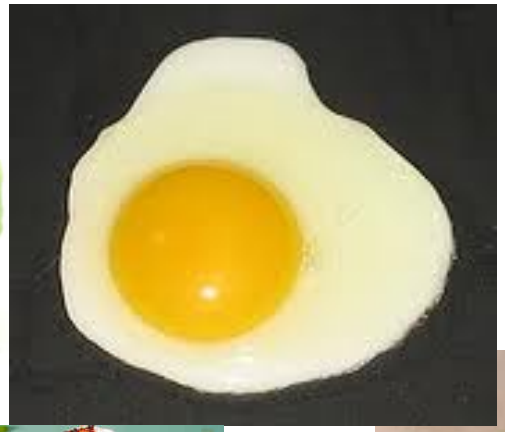
- Glyphosate chelates manganese
- Manganese deficiency leads to:
  - Disrupted gut bacteria → anxiety
  - Glutamate and ammonium toxicity in the brain as well as glutamine deficiency
  - Mitochondrial damage
  - Impaired bone development and osteoporosis
  - Impaired development of perineuronal nets
- Many of these are associated with autism
- Effects on coral and starfish are related

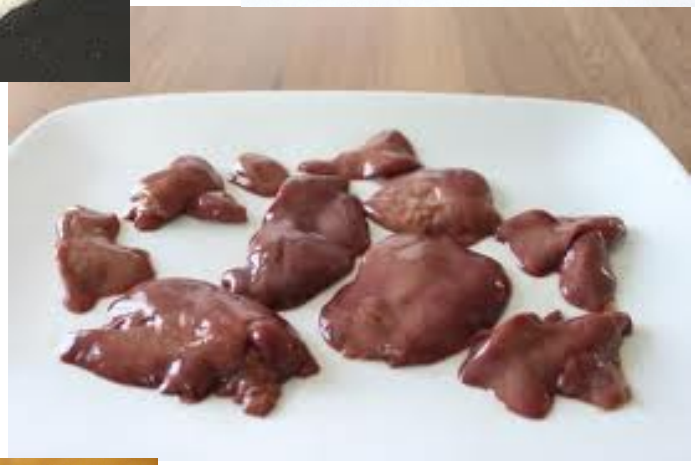
How You can Protect Yourself and Your Family

Go Organic!


QUE PASA
ORGANIC
Original Handcooked Recipe
Gluten-Free
Stone Ground
RAPUNZEL
ORGANIC CORN STARCH
ORGANIC BEST ALE
SAM SMITH
ORGANIC SHOYU
NATURALLY BREWED SOY SAUCE
PASTURE-RAISED
Organic HALF & HALF
Pasture-Raised
ORGANIC VALLEY
FARMER-OWNED
Organic HALF & HALF
PINT (473 mL)
Ultra Pasteurized
Organic Sweet Cream
ORGANIC VALLEY
4 QUARTERS Salted Butter
FARMER-OWNED

Eat Foods High in Sulfur





Eat Foods Containing Manganese









Hang Out in the Water at the Seashore

Escape to a sunny place in winter!

Epsom Salts!

Magnesium Sulfate in hot bath water is a cheap and easy way to get sulfate supply to the skin

Infrared heat also beneficial!

Take Off the Sunglasses and Look at the Blue Sky!

Don’ts!

Summary

- The autism epidemic is caused by:
  - Glyphosate working synergistically with aluminum and mercury and insufficient sun exposure to the skin and eyes
  - Diet depleted in micronutrients: vitamins and minerals
- Glyphosate's chelation of metals is a core component of its toxicity
  - Disrupted gut bacteria leads to brain pathology
  - Aluminum, mercury and manganese can account for many aspects of autism
  - Pineal gland plays an important role in brain dysfunction
- Autism may be treatable through organic diet enriched in sulfur and manganese, along with abundant sun exposure