Sulfate Deficiency in Neurological Disease Following Aluminum and Glyphosate Exposure

Stephanie Seneff
June 2, 2015

"If we all worked on the assumption that what is accepted as true is really true, there would be little hope of advance."

-- Orville Wright
Outline

• Introduction
• Sulfate
• Melatonin and the pineal gland
• Aluminum-glyphosate synergy
• Sulfate, vitamin D and autism
• Anemia and hypoxia
• Manganese dysbiosis
• Glyphosate and mitochondria
• Iron and mycoplasmas
• Sulfate and histamines *(if time!)*
• Summary

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What happens to us in the modern world

- Toxic chemicals in the food destroy the gut and then the liver and then the kidneys and the heart and the brain
- Toxic metals work synergistically with glyphosate (Roundup) to cause harm
- Drugs make things worse by disrupting essential biological pathways
- We develop many painful and debilitating chronic illnesses

At the Cellular Level...

- Cells deficient in cholesterol sulfate can’t recycle their garbage
- They have two options:
  1. Proliferate to dilute the garbage
  2. Die and let a macrophage clean up the mess
- When even the macrophages are sick:
  - Proliferation is the only option → cancer
  - Prostate cancer cells produce cholesterol sulfate
  - Breast cancer cells produce estrone sulfate → good substitute for cholesterol sulfate
At the Cellular Level...

Neurons in the brain clear their cellular debris while we sleep, and they depend upon sulfate to do this.

- Prostate cancer cells produce cholesterol sulfate
- Breast cancer cells produce estrone sulfate → good substitute for cholesterol sulfate

Wake-Sleep Cycle*

“Circadian signals are more important than food or exercise for wellness. Wellness is about optimized circadian signal specificity and sensitivity.”

Jack Kruze, MD

*jackkruse.com/tensegrity-4-magnetism-electrons-sleep/
(Thanks to Lienke Katz for pointing me to Jack Kruze’s writings)
Wake-Sleep Cycle*

Healthy circadian rhythms depend on sulfate

Jack Kruze, MD

*jackkruse.com/tensegrity-4-magnetism-electrons-sleep/
(Thanks to Lienke Katz for pointing me to Jack Kruze’s writings)

Hospital Discharge Diagnoses of Sleep Disorders
(ICD 327, 780.50-59, 307.41-49)
& Glyphosate applied to corn & soy crops
R= 0.9876, p<=7.744e-06
Sources: CDC; USDA

P < 0.0000077
Hospital Discharge Diagnoses of Sleep Disorders (ICD 327, 780.50-59, 307.41-49) & Glyphosate applied to corn & soy crops
R = 0.9876, p<=7.744e-06
Sources: CDC; USDA

Sleep disorder per 100,000

To t a l  g l y p h o s a t e / t o t a l  a c r e a g e
(lb/acre; corn & soy)

Year

U.S. Market is 25% of World Market of Roundup

Sleep disorder is associated with depression, Alzheimer’s disease, dementia, Parkinson’s disease, ADHD, multiple sclerosis and autism.
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A Provocative Proposal

• Cholesterol sulfate supplies oxygen, sulfur, cholesterol, energy and negative charge to all the tissues
• Sulfate is synthesized from sulfide in skin and blood stream utilizing energy in sunlight
  – Protects from UV damage and keeps microbes out
• Endothelial Nitric Oxide Synthase (eNOS) performs the magic

The skin is a solar powered battery!
eNOS is Very Vulnerable*  

- eNOS depends on:  
  - Cobalamin (vitamin B12, cobalt)  
  - Heme iron, sulfur, zinc, oxygen  
  - Glutathione  
  - Sunlight  
  - Tryptophan: converts UV to blue light; source of NAD  

- eNOS is a cytochrome P450 enzyme:  
  - Highly vulnerable to various environmental toxicants like mercury, aluminum, glyphosate, etc.  

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

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Cholesterol and Cholesterol Sulfate

Sulfation makes cholesterol water-soluble and therefore much easier to transport.
Heart Disease Mortality and Sunlight*

*Grimes et al., Q. J. Med. 1996; 89:579-589

Swedish Population Study on Sun Exposure*

“We found that all-cause mortality was inversely related to sun exposure habits. The mortality rate amongst avoiders of sun exposure was approximately twofold higher compared with the highest sun exposure group”

*PG Lindqvist et al., Journal of Internal Medicine, 2014, 276; 77–86
Sulfate is Vastly Underappreciated!

• Sulfate is the 4th most abundant anion in the blood and protects it from coagulating
• Detoxifies drugs, food additives, and toxic metals
• Essential component of extracellular matrix proteins throughout the tissues and vasculature
• Cerebroside sulfate is a major constituent of myelin sheaths surrounding axons in neurons

Sulfated Biomolecules*

• Sulfated mucopolysaccharides (glycosaminoglycans)
• Steroid sulfates
• Phenol sulfates
• Tyrosine sulfate
• Bilirubin sulfate
• Arylamine sulfates
• Choline sulfate in lichens, fungi and marine algae
• Sulfolipids

Sulfated Glycosaminoglycans (GAGs) (also called “Mucopolysaccharides”)

- Prominent in extracellular matrix of all cells
- Amount of sulfate depends on availability
- Crucial for maintaining negative charge and protecting from infection

http://www.science-autism.org/sulphate.htm

Various Factors that Increase Sulfate*

An increase of the 35S-sulfate deposit is effected regularly by infections, by injections of toxins and proteins, by hypoxemia, dietetic influence, muscular over-exertion, weather influence and increase of the blood pressure.

SMPS= Sulfated mucopolysaccharides

Fig. 2: Selected examples of factors that cause an increase of the SMPS synthesis, illustrated at the parameter of the 35S-sulfate deposit in the connective tissue of various organs.

SMPS = Sulfated mucopolysaccharides = glycosaminoglycans

First published in the German language in the SANUM-Post magazine (17/1991)
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A Hypothesis

Many neurological diseases of the brain have a common origin:

– Insufficient supply of sulfate to the brain
– Enhanced 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, including damaged mitochondria
**In Brief...**

- Heparan sulfate in the lysosomes is critical for recycling cellular debris
  - Heparan sulfate deficiency leads to autism
- Pineal gland delivers sulfate to cerebral spinal fluid via melatonin
- Aluminum and mercury disrupt pineal gland
- Sunlight deficiency is a contributing factor
- Glyphosate works synergistically with aluminum

**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**

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

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


A Really Bad Idea!
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***

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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: \( \text{Al} + 1.5 \times (\text{Al w/ Hg}) + 2.0 \times \text{Hg} \)

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
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
• Aluminum accumulation in pineal gland would disrupt sulfate supplies to brain

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

We live in the age of aluminum*

We live in the age of aluminum


Aluminum Nanoparticles: Highly Destructive in the Brain

- Destroyed mitochondria and severely depleted ATP
- Induced autophagy and programmed cell death
- Increased permeability of blood brain barrier
- Were persistent
- Far more damaging than larger sized aluminum particles

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

Aluminum Glyphosate*

Six different ways two glyphosate molecules can chelate aluminum

* M. Purgel et al., Journal of Inorganic Biochemistry 103 (2009) 1426–1438
**Glyphosate Suppresses Melatonin Synthesis!**

- Glyphosate interferes with shikimate pathway in plants and microbes $\rightarrow$ tryptophan depletion*
- Tryptophan is sole precursor to melatonin
- Melatonin binds to aluminum, cadmium, copper, iron and lead, reducing their toxicity**

* *N. de María et al., J Agric Food Chem 2006, 54, 2621-2628.

**Autism, Glyphosate, Vaccine Reactions***

*Collaboration with Nancy Swanson
MIT Computer Science and Artificial Intelligence Laboratory
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**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 bloodstream)

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

**Autism-like socio-communicative deficits and stereotypies in mice lacking heparan sulfate**

- 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., PNAS Mar. 27, 2012, 109(13), 5052-5056.*
“Heparan sulfate deficiency in autistic postmortem brain tissue from the subventricular zone of the lateral ventricles”*

“Aberrant extracellular matrix glycosaminoglycan function localized to the subventricular zone of the lateral ventricles may be a biomarker for autism, and potentially involved in the etiology of the disorder.”

*BL Pearson et al., Behav Brain Res. 2013;243:138-45

New neurons develop from stem cells in this zone through the action of “fractones” composed of heparan sulfate proteoglycans**

**F. Mercier et al., Neuroscience Letters 506 (2012) 208–213
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


Vitamin D Deficiency Epidemic

Plot derived from hospital discharge data from the CDC
Vitamin D Deficiency Epidemic

Vitamin D depends on CYP enzymes for activation in the liver and the kidney

Plot derived from hospital discharge data from the CDC

Vitamin D Deficiency Epidemic

Vitamin D protects from sulfate wasting from the kidneys*

Plot derived from hospital discharge data from the CDC
Vitamin D Deficiency Epidemic

Autism is associated with vitamin D deficiency, low serum sulfate and high urinary sulfate*

Plot derived from hospital discharge data from the CDC

Inflammation and Vitamin D: The Infection Connection*

• The problem appears to be a bottleneck in the production of 25(OH) vitamin D in the liver
  \[D3 \rightarrow 25(OH)D3 \rightarrow 1,25(OH)2D3\]
  Liver                     Kidney
• Both steps depend on CYP enzymes
• Liver CYPs are destroyed by glyphosate and aluminum??
  \[\rightarrow 1,25(OH2)D3 \gg 25(OH)D3\]

*M. Mangin et al., Inflamm Res 2014; 63:803-819.
Recent Study from China*

*Z-L Gong et al., NeuroReport 2014, 25:23–27

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Glyphosate: The Central Mechanisms

• Glyphosate acts as an antibiotic to disrupt gut bacteria, leading to overgrowth of pathogens
• Disruption of liver CYP enzymes leads to impaired bile flow and low vitamin D
  – This disrupts sulfate synthesis and transport
  – Also impairs detoxification of other toxic chemicals
• Damage to red blood cells leads to anemia and toxicity due to free iron
  – Hypoxia ensues \(\rightarrow\) low grade encephalopathy
• Manganese, aluminum and glutamate become toxic to the brain

This Detoxification Scheme is Essential in Red Blood Cells

Glucose-6-phosphate

6-Phosphogluconate

Inhibited by glyphosate

Product of shikimate pathway

Depleted by glyphosate

Induced by excess folic acid

Depends on selenium

Glutathione reductase

GSH

GSSG

Glutathione peroxidase

H₂O₂

H₂O

NADP

NADPH
This Detoxification Scheme is Essential in Red Blood Cells

G6PD Deficiency Leads to Hemolysis and Anemia

Depleted by glyphosate
Depends on selenium

Glyphosate also interferes with heme synthesis needed to replenish RBCs
Anemia leads to low oxygen which induces chronic low grade encephalopathy linked to autism
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Paper on Glyphosate and Manganese
Published March 24, 2015

Surgical Neurology International

Original Article

Glyphosate, pathways to modern diseases III: Manganese, neurological diseases, and associated pathologies

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Received 22 September 14 Accepted 31 January 15 Published 24 March 15
Severe Deficiency in Serum Manganese and Cobalt in Cows*

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

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

Manganese and Autism*

- Glyphosate chelates manganese
- Manganese disruption leads to:
  - Disrupted gut bacteria $\rightarrow$ anxiety
  - Impaired dopamine synthesis $\rightarrow$ thyroid disease
  - Glutamate and ammonium toxicity in the brain
  - Mitochondrial damage (impaired Mn-SOD)
  - Impaired bone development and osteoporosis
  - Impaired development of perineuronal nets
- Many of these pathologies are associated with autism

Low Manganese in Teeth Linked to Autism*

• Studied lead, mercury and manganese levels in tooth enamel of shed primary teeth in 84 children
• Manganese accumulated after birth was down by 60% in autistic children
• No other result was statistically significant


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• No other result was statistically significant

It’s not just deficiency!

Too much manganese in the brain stem
Too little manganese in the cortex

Balancing the Scales

Autism
ADHD
Alzheimer’s
Parkinson’s

Glyphosate disrupts the body’s ability to distribute the minerals safely: Everybody walks a tight rope between deficiency and toxicity
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Glyphosate & Mitochondria
**Pesticides and Neuroinflammatory Response**

*Figure 1, HR Dhaini, Encyclopedia of Neuroscience, Chapter 14, Springer Berlin Heidelberg, D, Hirokawa N, Windhorst U, Ed. pp.2734-2739*

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**Autism and Mitochondrial Impairment**

- Mitochondrial impairment is a key feature of autism, especially in the brain
  - Impaired detox of glutamate by astrocytes (requires manganese)
  - Excess stimulation of NMDA receptors in neurons
- Glyphosate excites NMDA receptors and prevents glutamate metabolism

*Dayan Goodenowe and Elodie Pastural, Chapter 4, intechopen.com/books/autism-a-neurodevelopmental-journey-from-genes-to-behaviour/the-biochemical-basis-of-autistic-behavior-and-pathology*
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

Mitochondria are Key!

“Damage to mitochondria is now understood to play a role in the pathogenesis of a wide range of seemingly unrelated disorders such as schizophrenia, bipolar disease, dementia, Alzheimer's disease, epilepsy, migraine headaches, strokes, neuropathic pain, Parkinson's disease, ataxia, transient ischemic attack, cardiomyopathy, coronary artery disease, chronic fatigue syndrome, fibromyalgia, retinitis pigmentosa, diabetes, hepatitis C, and primary biliary cirrhosis.”*

*J Neustadt and SR Pieczenik, Molecular Nutrition and Food Research 2008;52:780-788
Mitochondria are Key!

Many of these conditions are going up in prevalence in step with glyphosate usage on corn and soy crops

Alzheimer's disease, epilepsy, migraine headaches, strokes, neuropathic pain, Parkinson's disease, ataxia, transient ischemic attack, cardiomyopathy, coronary artery disease, chronic fatigue syndrome, fibromyalgia, retinitis pigmentosa, diabetes, hepatitis C, and primary biliary cirrhosis.

Glyphosate makes manganese unavailable to mitochondria, and they need manganese to protect them from oxidative damage.

Microglia are Crucial for Synaptic Transmission*

• Microglia are the immune cells of the brain
• Microglia have their “fingers” on the pulse of synaptic transmission by neurons
• Microglial activation by toxic stimuli provokes astrocytes to release glutamate which is then metabolized by neurons in the mitochondria in place of sugar

This signals that mitochondrial complex I is sick

*J Neustadt and SR Pieczenik, Molecular Nutrition and Food Research 2008;52:780-788

Microglia are Crucial for Synaptic Transmission*

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Glyphosate interferes with its conversion to glutamine

Glutamate metabolism by mitochondria bypasses Complex I (unlike glucose)


Mechanisms underlying the neurotoxicity induced by glyphosate*

“Taken together, these results demonstrated that Roundup® might lead to excessive extracellular glutamate levels and consequently to glutamate excitotoxicity and oxidative stress in rat hippocampus. “ - quote from abstract

*D Cattani et al., Toxicology 320 (2014) 34–45
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Iron is Essential but Toxic

• Glyphosate interferes with heme synthesis – this greatly increases the problem of free iron in the blood
• *Fenton reaction* leads to hypersensitivity to hydrogen peroxide $\rightarrow$ damage to delicate cellular membrane fatty acids
• “ROS” = reactive oxygen species
Heparin Protects from ROS due to Iron*

Free radical production (*Fenton reaction*):

\[
\text{Fe(II)} + \text{O}_2 + 2\text{OH}^- \rightarrow \text{Fe(III)}(\text{OH})_2 + \text{O}_2^-
\]

But, in the acidic environment of heparin:

\[
4\text{Fe(II)} + \text{O}_2 + 4\text{H}^+ \rightarrow 4\text{Fe(III)} + 2\text{H}_2\text{O}
\]


“Chronic and age-related increases in ROS production will cause mitochondrial damage and dysfunction that perpetuate a catastrophic cycle of cellular injury, further ROS generation, mitochondrial decline, and cell death.”*

* S.W. Ballinger et al., Circ Res. 2000;86. P. 965
Eventually the Mitochondria Become so Impaired that they can’t produce ATP

- Is this why mycoplasmas come into play??
- Mycoplasmas are tiny bacteria *without a cell wall*
- Micoplasmas can produce ATP without CYP enzymes: a SUPER benefit when CYPs are impacted by toxic chemicals in the environment

Mycoplasmas

- Smallest bacteria yet discovered
- Can live without oxygen
- Can not live outside of a host cell
- Generate ATP from arginine
  
  \[
  \text{arginine} \to \text{citrulline} + \text{ammonia}
  \]
- They have no cytochromes!!! (SAFE)
- Associated with gastric cancer, lung cancer, renal cancer, prostate cancer, colon cancer
- *Hide inside immune cells and inactivate the vitamin D receptors!*
**Mycoplasma: Safe Metabolism to generate ATP for the host cell!!**

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>arginine deaminase</td>
<td>Arginine + H₂O → Citrulline + NH₃</td>
</tr>
<tr>
<td>ornithine carbamoyltransferase</td>
<td>Citrulline + inorganic orthophosphate → Ornithine + CarbamoylPO₄</td>
</tr>
<tr>
<td>carbamate kinase</td>
<td>CarbamoylPO₄ + ADP → ATP + CO₂ + NH₃</td>
</tr>
</tbody>
</table>

Another mechanism for ATP generation is:

<table>
<thead>
<tr>
<th>Reaction</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>phosphate acetyltransferase</td>
<td>Acetyl CoA + inorganic orthophosphate → acetyl PO₄ + CoA</td>
</tr>
<tr>
<td>acetate kinase</td>
<td>Acetyl PO₄ + ADP → Acetate + ATP</td>
</tr>
</tbody>
</table>

Ammonia!

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Sulfate and Histamines

Heparan Sulfate Promotes Histamine Breakdown*

- Intestinal diamine oxidase (DAO) is synthesized in the mature enterocytes of the villus tip and is then transported to the binding sites on the intestinal vasculature.
- Heparin and heparan sulfate induce release of the bound DAO, so that it can break down histamine

*Conclusion: deficiencies in heparan sulfate lead to build-up of histamines!

**Symptoms Caused by Histamines**

![Symptoms Caused by Histamines Diagram](image)

*Figure 1, L. Maintz and N. Novak, Am J Clin Nutr 2007;85:1185–96.*

**DAO Deficiency → Histamine Accumulation**

<table>
<thead>
<tr>
<th>System</th>
<th>Adverse Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central nervous system</td>
<td>Migraine, headache, hangover, sickness</td>
</tr>
<tr>
<td>Cardiovascular system</td>
<td>Hypotension, hypertension and arrhythmia</td>
</tr>
<tr>
<td>Epithelial system</td>
<td>Urticaria, atopic skin, psoriasis</td>
</tr>
<tr>
<td>Respiratory system</td>
<td>Nasal congestion, asthma</td>
</tr>
<tr>
<td>Digestive system</td>
<td>Irritable bowel syndrome, constipation, satiety, stomachache, vomits</td>
</tr>
<tr>
<td>Muscular system</td>
<td>Fibromyalgia, muscular pains</td>
</tr>
<tr>
<td>Skeletal system</td>
<td>Bone pains</td>
</tr>
</tbody>
</table>

*www.deficitdao.org/dao-deficiency/#.VRWYtWZGqDc*
Summary

• Autism and Alzheimer’s disease have reached epidemic proportions in the Western world
  – Hypothesis: Both are caused by a severe deficiency in sulfate supplies to the brain
• Pineal gland can synthesize sulfate stimulated by sunlight and deliver it via melatonin sulfate
  – Aluminum and glyphosate work synergistically to derail this process
  – Sunlight deficiency contributes to the pathology
• Mitochondrial disorder: mycoplasmas and histamines arise from impaired sulfate supplies