IHHS-HEALTH & WELLNESS CENTER

1607 SO. H STREET
BAKERSFIELD, CA 93304
(661) 837-0453 ~ FAX (661) 837-0560
The Local People Serving You

Correcting Sulfur Deficiency for Health

Sulfur is the sixth most abundant macromineral in breast milk and the third most abundant mineral based on percentage of total body weight. The sulfur-containing amino acids (SAAs) are methionine, cysteine, cystine, homocysteine, homocystine, and taurine. MSM, or methysulfonylmethane, is another form of sulfur found in foods that is essential for health. Vegan athletes, children, or patients with HIV, because of an increased risk for SAA deficiency, and protein should consider supplementation of both MSM & SAA's.

Organic sulfur, as SAAs & MSM, can be used to increase synthesis of S-adenosylmethionine (SAMe), glutathione (GSH), taurine, and N-acetylcysteine (NAC), says S. Parcell from the American Institute for Biosocial and Medical Research (AIBMR).

Sulfur in the form of MSM may be effective for the treatment of allergy, pain syndromes, athletic injuries, and bladder disorders. Sulfur compounds such as SAMe, dimethylsulfoxide (DMSO), taurine, glucosamine or chondroitin sulfate, and reduced glutathione may also have clinical applications in the treatment of a number of conditions such as depression, fibromyalgia, arthritis, interstitial cystitis, athletic injuries, congestive heart failure, diabetes, cancer, and AIDS.

Sulfur is required to regenerate our cells. Otherwise**, when sulfur is lacking, then our cells deteriorate and age**. This is very visible in the hair, nails and skin, but a deficiency of sulfur is deeply felt in cells and tissues throughout the body. This can be easily corrected with MSM supplementation.

Sulfur is the simplest of three elements able to carry oxygen into the cells where it is used in the mitochondria to release energy from nutrients. Additionally, the body uses sulfur to make proteins: amino acids, enzymes, hormones, and connective tissue.

Sulfur is a chemical element that is present in all living tissues. After calcium and phosphorus, it is the third most abundant mineral in the human body. Sulfur is also found in garlic, onions and broccoli.

MSM/sulfur can be taken by mouth for a myriad or reasons including: shortness of breath, allergies, swelling in the back of the throat (pharyngitis), high cholesterol, clogged arteries, menopause, and upper respiratory tract infections like the common cold.

Sulfur can be applied to the skin as a gel for acne, hayfever, skin redness (rosacea), dandruff, scaly and red skin patches (seborrheic dermatitis), an itchy skin infection caused by mites (scabies), lice, cold sores, warts, and poison oak, ivy, and sumac infections.

Why does it work?
Sulfur is present in all living tissues. Sulfur seems to have antibacterial effects against the bacteria that cause acne. It also might help promote the loosening and shedding of skin. This is believed to help treat skin conditions such as seborrheic dermatitis or acne.

How Does Organic Sulfur work?
Cells walls regain their permeable state when there is sufficient organic sulfur available, allowing oxygen and nutrients to pass through into the cells, and cellular wastes to pass out.

When there isn't enough oxygen available in the cells, energy is formed by an anaerobic (without oxygen) process which is less efficient and energy becomes low.

Also when wastes can't pass out easily, cells become inflamed, and the result is pain and poorer health.

As oxygen is pushed into the cells, the waste garbage is pushed out - including metabolic by-products, chemical pollutants that have been stored, metal and drug residues. The sulfur reacts with these elements and neutralize them and carries them safely out of the body through lymph and urine. This is true natural cleansing at a cellular level!

When these toxic substances are flushed out of the body, it can heal and be pain-free. Scars dissolve over time as cells are replaced, and proper function is restored in the body. It is truly an anti-aging miracle!

Sulfur helps protects the body from free radical damage, inflammation all over the body, balances blood chemistry, protects from stroke via production of heparin sulfate, and cleanses the liver via cholesterol sulfate to aid in reduction of cholesterol, and reducing plaque in blood vessels.

The present of oxygen also creates an internal environment that is hostile to viruses, bacteria, fungus and parasites.

Why are We Missing Essential Sulfur?

Unfortunately, organic sulfur is missing from our foods now, leaving our bodies malnourished and prone to be congested with toxic wastes, damaged by free radicals and often in pain. This, of course, creates a failure to function, as well as we need to, in life.

In the days before petro-chemical fertilizers, farmers added animal manure to fields, naturally enriching the soil with high levels of sulfur for crops. Also, sulfur was normally present in even in unfertilized soils, available as part of a natural sulfur cycle, moving from volcanic gas in the ocean, then released into the air, finally to fall in rainwater into the soil.

Since 1954 chemical fertilizers have been used by farmers that combine with the sulfur naturally present and removes it from availability for plants or humans. Even when these fertilizers contain sulfides, these lack bioavailability and we are starving for energy. We appear to have broken the Sulfur cycle in countries that use chemical fertilizers.

As Mike Adams of NaturalNews.com said so well, "Today, the industrialized farming and transportation methods employed by the large agri-giants that grow most of our food have virtually eliminated necessary sulfur from not only the soil, but from food itself. And what little sulfur is left in food gets eliminated through processing, refrigeration, dehydration and cooking."

1. **Sulfur is the third most abundant mineral in the body, about half being concentrated in the muscles, skin and bones, and is essential for life.** Sulfur makes up vital amino acids used to create protein for cells, tissues, hormones, enzymes, and antibodies. The body uses up its store daily so it must be continually replenished for optimal health and nutrition.

2. **Sulfur is needed for insulin production.** Insulin controls carbohydrate metabolism, but insufficient sulfur makes it harder for the pancreas to produce enough insulin, and makes cells less able to absorb things from the blood, contributing to blood sugar problems.

3. **Sulfur detoxifies at the cellular level and relieves pain.** Healthy cells can absorb adequate nutrients while releasing toxins and wastes. Sulfur affects this by helping your body build strong breathable cell walls that properly balance cell pressure. Having enough sulfur helps your body to remove toxins that may suffocate the cells, or swell them, causing pain, allergies, stiffness, and muscle soreness!

4. **Sulfur builds flexible cells in the arteries and veins - the opposite of "hardening of the arteries".** Elastic, "breathable" blood vessel tissues are able to pass oxygen and nutrients through their walls to nourish the rest of the body and handle the body's blood flow without stress.

5. **Sulfur has been called nature's "beauty mineral" because it keeps your complexion clear and youthful and hair glossy and smooth.** Collagen production in your body depends on sulfur to create healthy skin and heal scars. For example, sulfur improves acne by resolving scars, removing toxins from the skin and creating healthy new skin cells. When you have enough sulfur in your body, your skin and hair are more flexible, softer, and smoother.

6. **Where is organic sulfur found in nature?** Where do we get organic sulfur we can use? From rainwater and seawater absorbed by plants. Plankton in our oceans absorb it from underwater volcanoes and then release sulfur compounds back into seawater as part of their natural cycle. This is converted to DMS, a gas sulfur compound that bubbles up into the atmosphere. Ozone and ultraviolet sunlight change the sulfur gas to DMSO and Methylsulfonylmethane, known as MSM. The rain now contains MSM which is spread over the oceans and land where it is absorbed by plants and seaweed.

7. **We don't eat a large diet of foods rich in organic sulfur like people used to.** For most of human history, we could eat fruits and vegetables fresh from the ground and not have to give a second thought to getting this essential nutrient. However, food storage, transport, processing, cooking, even washing and drying, degrades MSM, and due to our modern lifestyle we have lost access to the MSM our bodies expect. Also with air pollution and degradation of our soil and water, it has become essential to make sure we supplement our diets with bio-available sulfur to get enough for optimal health.

8. **MSM has an amazing anti-parasitic action.** When parasites attach to someone's intestinal lining, they can live, reproduce and leach nutrients from the body indefinitely. MSM blocks parasites by competing for receptor sites on the mucous membrane. When parasites can not attach themselves, they are simply flushed out of the system with the excess MSM.

9. **MSM has anti-allergic properties.** MSM has an ability to bind to mucuous membranes and form a natural block against allergens. Another way MSM can alleviate allergies is through detoxification, elimination of free radicals, and improvement of cell permeability. Several authors, including Beth M. Ley in her book-*MSM: On Our Way Back to Health With Sulfur*, have noted that MSM works as a safe histamine inhibitor, at least as well as the traditional antihistamines, without the negative side effects.

10. **MSM and Vitamin C.** Your body uses MSM along with Vitamin C to create new, healthy cells and connective tissue. MSM helps determine how flexible the bond is between the cells. An adequate supply of MSM and Vitamin C supports healthy cell regeneration. As your new cells are created, MSM is incorporated into the bonds that make up cells walls. The result is the creation of cell walls that are better able to absorb nutrients.

IHHS-HEALTH & WELLNESS CENTER

1607 SO. H STREET
BAKERSFIELD, CA 93304
(661) 837-0453 ~ FAX (661) 837-0560
The Local People Serving You

Methylsulfonylmethane (MSM) is 34% sulfur, making it the richest source of bio-available organic sulfur.***MSM is safe, non-allergenic and easily digestible as a food.***

Sulfa allergy: It is commonly thought that people who are allergic to sulfa drugs might be allergic to sulfur containing products. This is not true. People with an allergy to "sulfa" react to the sulfonamide in some antibiotics and related drugs. They do not react to elemental or organic sulfur. We currently have no information for SULFUR Interactions

Supplementation with MSM: There is one concern with high dose MSM. Once again, I'm not concerned if you're planning to use MSM for just a few months. But if you start using it at age 50 or 60, and it helps relieve your pain, you're likely to take it for another 20 to 30 years or so.

So if you plan to take MSM for many years because it helps your joints (or for any other reason), you should try to eat an entirely organic diet to make sure you're getting enough molybdenum to offset the sulfur in the MSM. If eating an entirely organic diet isn't possible for you, then supplement at least 50 micrograms of molybdenum for every 1,000 milligrams of MSM. Symptoms of deficiency are: increased respiratory or heart rate, night blindness (difficulty with seeing in the dark), mouth and gum disorders, sexual impotence in older males, sulfite sensitivity (if molybdenum level is not enough for detoxification).

MSM Bulk Flake & Capsules

Systemic support treatments include but not limited to:

1. Should increase your energy level in 7 to 10 days or sooner.
2. Should make your immune system stronger & healthy within 14 days.
3. At 10 to 14 days or sooner, pains are dramatically reduced or eliminated.
4. MSM has been proven in clinical studies to detoxify the liver,
5. Reduce or eliminate muscle cramps and spasms.(ie. Restless Leg Syndrome).
6. Skin changes texture as the collagen retains most moisture.
7. Digestive problems are dramatically reduced or eliminated.
8. Asthma symptoms are reduced or eliminated.
9. Removes inflammation and dilates the blood vessels and increases blood flow.
10. Helps reduce or eliminate allergies to food, grass and pollens.
11. Hair and nails grow much faster and stronger.

IHHS-HEALTH & WELLNESS CENTER

1607 SO. H STREET
BAKERSFIELD, CA 93304
(661) 837-0453 ~ FAX (661) 837-0560
The Local People Serving You

MSM can effectively decrease, if not eliminate, pain from, Sore Muscles, Morning Stiffness, Muscle Strains, Back, Neck, Shoulders, Knees, Ankles, Hips, Elbow, and Wrist Joints.

Some people with chronic pain will require more MSM.

Some at levels ranging from 15,000 to 60,000 mgs/day !

This would be chronic conditions such as Fibromyalgia, Chronic Fatigue Syndrome, Arthritis, both Rheumatoid and' Osteoarthritis, Lupus and many others !

"MSM" Distilled 4 times for Purity!

No Known Side Effects No Known Allergic Reactions No Known Drug Interactions

All this after 35 years of research at "Oregon Health Sciences University"

IHHS-HEALTH & WELLNESS CENTER

1607 SO. H STREET
BAKERSFIELD, CA 93304
(661) 837-0453 ~ FAX (661) 837-0560
The Local People Serving You

Joint Muscle and Tissue Support Gel

Made with the only patented, 4 times Distilled MSM, with a pure ***therapeutic aloe vera gel base!***

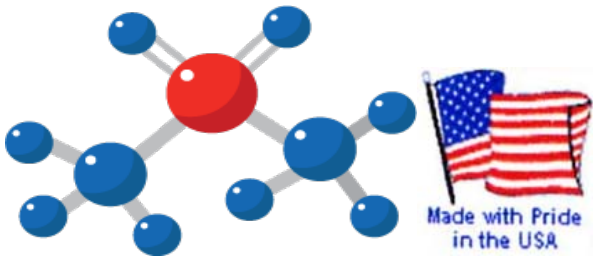
Our gel is at 19% MSM content!

No Odor ***No Oils*** ***No Dyes***

Distilled 4 times for Purity!

In the process of distillation of MSM, bacteria and heavy metals are removed. Lignusul MSM is from China and India and ***is not*** distilled and contains bacteria and heavy metals.

Why MSM?



MSM (methylsulfonylmethane), also known as dimethyl sulfone (DMSO2) and methyl sulfone, is an organic sulfur-containing compound that is essential for optimal health. Without sufficient MSM sulfur, your body cannot maintain an appropriate level of homeostasis. MSM® has earned the reputation for the purest, safest, and most consistent MSM in the world.

MSM*is (methylsulfonylmethane)* ***Pure Organic Food Grade Nutritional Sulfur !***
This is not a Sulfa Drug ! You cannot be allergic to this MSM !

Our MSM Pain Gel is the only MSM Gel with 19%MSM the most concentrated formula on the market today. We were the first & original MSM Pain Gel !

A Natural Anti-Inflammatory
Not an analgesic as they only mask the pain and block the signal to the brain!
MSM Pain Gel allows your body to heal faster by removing the inflammation that causes the pain!
All pain is inflammation of soft tissue*!*

Direction for Application of Pain Gel

One layer for minor pain. Two layers for moderate pain. Three layers for severe pain.
Apply to the area. Do not rub in!
Coat the area, then let it soak in for one minute, then apply another layer.
The key is to wait at least one minute, in between applying the layers.

IHHS-HEALTH & WELLNESS CENTER

1607 SO. H STREET
BAKERSFIELD, CA 93304
(661) 837-0453 ~ FAX (661) 837-0560
The Local People Serving You

MSM

As An Ageless Eye and Face Serum

Reduces Puffiness Under and Around the Eyes
Enhances Skin & Collagen Hydration
Tightens and Firms Facial Tissue
Helps Eliminate Dark Circles
Eliminates Acne Rapidly

Seventy five percent of our skin is comprised of water and collagen, the connective tissue that makes up our skin. Our skin is exposed to harsh UVA and UVB radiation resulting in age spots, fine lines, and wrinkles. As we age, our bodies produce less and less collagen and what we do have remaining simply starts to dry out and shrink up, leading to the formation of wrinkles and fine lines.

Most anti-aging products use fragments of hydrolyzed collagen containing molecules too large for the skin with conventional formulas. MSM Health Solutions breakthrough formula, 17 years in development, now, delivers exactly what the collagen molecules in the skin need to make them soft and permeable so they can retain fluid and plump up so that fine lines and wrinkles slowly disappear .

The **"MSM"**-rich Eye & Face Serum is applied to the skin, rebuilding and rejuvenating the collagen and surrounding tissue.

MSM Reduces Puffiness Under and Around the Eyes by removing the Inflammation or the pooled fluid that is evident especially around the eyes. "**MSM"**, is a natural anti-inflammatory. It will remove the excess fluid very rapidly.

Enhances Skin & Collagen Hydration because our **"MSM"** molecule is small enough to penetrate the pours of your skin, this sulfur molecule is the one substance on earth that can penetrate the collagen and allow it to become soft and permeable and then retain fluid to plump up, therefore raising fine lines and wrinkles. Restores Your Radiant, Firmer Skin.

Helps Eliminate Dark Circles because as the collagen dries up and shrinks, the surrounding tissue as well as the collagen changes. This is brought on because of environmental issues in the air around us daily as well as foods we eat and simply our bodies changing as we age. The**"MSM"** in high concentration in our Serum, counter acts these changes and therefore the skin reacts and changes as well.

Eliminates Acne Rapidly because**"MSM"** is organic Food Grade Sulfur. This sulfur is anti-bacterial & anti-fungal. Acne is bacteria and dirt in the cells. If you clean the skin well and eliminate the bacteria, acne is eliminated very rapidly.

IHHS-HEALTH & WELLNESS CENTER

1607 SO. H STREET
BAKERSFIELD, CA 93304
(661) 837-0453 ~ FAX (661) 837-0560
The Local People Serving You

More Detailed Ways Sulfur Helps the Body

Functions

Sulfur is a part of some of the amino acids in your body and is involved in protein synthesis, as well as several enzyme reactions It helps with the production of collagen, which is a substance that forms connective tissues, cell structure and artery walls. Additionally, it is a part of keratin, giving strength to hair, skin and nails.

Skin Disorders

Sulfur can help ease the effects of several skin disorders, including acne, psoriasis, warts, dandruff, eczema and folliculitis, which causes inflamed hair follicles. Creams, lotions and bar soaps containing sulfur are used to relieve swelling and redness related to acne. Dermatitis and scabies can be treated with a specialized sulfur ointment. Some sulfur treatments are available over the counter, but in severe cases, you may need a prescription from your dermatologist.

MSM Basics

MSM is also produced in your body, which means that you do not need to obtain it from your diet in order to sustain life. Due to the sulfur that is naturally contained in MSM, it helps to detoxify heavy metals and promotes healthy liver function. In addition, certified nutritional consultant Phyllis Balch says in her book, "Prescription for Nutritional Healing," that MSM promotes healthy hair, skin and nails.

MSM and Inflammatory Disorders

Alternative medical practitioners suggest that MSM supplements help treat chronic pain and a variety of inflammatory disorders, including rheumatoid arthritis, osteoporosis, bursitis, tenosynovitis, tendinitis and eye inflammation. According to "Natural Medicines Comprehensive Database," MSM is arguably

most commonly used for the treatment of osteoarthritis, and multiple studies have found that 3 g of MSM, twice daily, can modestly reduce osteoarthritis-related pain and swelling and enhance joint function. It should be noted, however, that some patients may not consider the modest benefit to be clinically significant.

MSM and Allergies

MSM helps to reduce histamine in your body, which is the inflammatory substance responsible for many allergy symptoms. MSM is therefore recommended by some alternative medicine practitioners for the treatment of allergies. "Natural Medicines Comprehensive Database" warns that as of 2011, only one clinical study has examined the effectiveness of MSM as an anti-allergy treatment. The study was cited in the April 2002 edition of "Journal of Alternative and Complementary Medicine" and it examined the effects of MSM on seasonal allergic rhinitis. The 50 subjects who participated were given 2,600 mg of MSM daily for 30 days. At the end of the study, the participants experienced a reduction in respiratory and nasal symptoms as well as an increase in energy.

People also use MSM to help treat muscle cramps and pain, asthma, depression, scleroderma, scar tissue, stretch marks, hair loss, wrinkles, periodontal disease, gastrointestinal upset, chronic constipation, interstitial cystitis, gastric hyperacidity, ulcers, diverticulosis, premenstrual syndrome, poor circulation, hypertension and elevated serum cholesterol. In addition, MSM is used to help protect against sunburn and windburn and to promote wound healing. More research needs to be done to confirm the efficacy of MSM for these purposes, however

Weight Loss

There are no clinical studies on MSM and weight loss, only some testimonials from people who say that they think MSM has helped them to lose weight. Since MSM is important in insulin production and blood-sugar levels, it does affect energy levels and carbohydrate metabolism, and could have an indirect effect on weight loss. Because of its ability to alleviate joint problems and lessen pain, MSM may help

people become more active. The Mayo Clinic cautions against the use of MSM for any health condition, due to the lack of long-term studies.

Joint Problems

Researchers at Oregon State University studied a strain of mice prone to develop joint lesions like those of rheumatoid arthritis. Animals fed a diet that included a 3-percent solution of MSM showed healthy articular cartilage after three months, while mice receiving no treatment showed degeneration of articular cartilage.

The UCLA School of Medicine studied humans with degenerative arthritis. Sixteen patients, with 10 on MSM and six on a placebo, were studied for four months. In only six weeks, the patients on MSM had 80 percent control of pain, while those on placebo experienced an 18 percent improvement.

Although scientists do not know all the actions of MSM, researchers at Oregon Health Sciences University have found several conditions that respond well to MSM. It has helped allergic responses to pollens and foods so that medications may be reduced or eliminated. It has controlled hyperacidity with good results. Some patients with chronic constipation have had immediate and continuing relief from it. MSM is involved in the formation of collagen in the body, and improves hair, nails and skin. Sulfur helps with acid/alkaline balance in the body, which is important for overall health.

The supplement methylsulfonylmethane, sometimes called MSM, is a sulfur compound promoted as useful for health conditions involving pain and inflammation. A 2006 study involving 50 men and women with knee **osteoarthritis** indicates that 6,000 mg of MSM improved symptoms of pain and physical function without major side effects, according to Arthritis Today.

Unpublished MSM Hair Growth Study

MSM is frequently touted for its ability to improve hair and nails, although there is little to support those claims. The test most-often cited to support MSM as a hair growth agent was an unpublished study by Dr. Ronald M. Lawrence. Unpublished studies are not subject to peer review and are given less credence than published studies. Lawrence's study, titled "The Effectiveness of the Use of Oral Lignisul MSM

Supplementation on Hair and Nail Health," consisted of just 21 subjects, with 11 receiving 3,000 mg of MSM daily and 10 taking a placebo. At the end of the six-week study, Lawrence concluded that "hair length increases tended to be greater in MSM-treated males than in their placebo-given counterparts," but also wrote that larger-scale trials should be done.

Published MSM Hair Growth Study

One study that did find its way into the peer-reviewed press appeared in the July 2009 issue of "Biomolecules & Therapeutics." The study used MSM with magnesium ascorbyl phosphate, or MAP. The study was performed on laboratory mice and a constant 7.5 percent MAP solution was administered to the backs of mice with MSM solutions of 1 percent, 5 percent and 10 percent. The study showed that the hair growth rate was in direct relation to the percentage of MSM given to each test group, and that the 10 percent MSM solution mixed with the MAP worked as well as 5 percent minoxidil and concluded that MAP and MSM together appeared to be useful in treating hair loss.

Arthritis

According to the University of Maryland, sulfur has been shown to be effective for osteoarthritis, rheumatoid and psoriatic arthritis. Sulfur baths or mud-soaks can help alleviate the painful swelling caused by arthritis. Taking a sulfur bath at night can reduce stiffness you experience first thing in the morning. Additionally, sulfur baths can improve walking ability and overall strength. Applying a cream containing DMSO/MSM may reduce pain in some types of arthritis. Lastly, taking a supplement with 6,000 mg of MSM sulfur can reduce pain associated with arthritis, but it may have more beneficial effects when paired with glucosamine.

MSM for Rheumatoid and Osteoarthritis

MSM, or methylsulfonylmethane, is a sulfur-based compound that can relieve chronic joint pain resulting from inflammation, according to "Nutritional Supplements in Sports and Exercise." Rheumatoid arthritis is a chronic inflammatory condition that causes pain, stiffness, and a loss of mobility in various joints around your body and usually occurs due to over-stressing the cartilage within your joints. MSM

can relieve arthritis pain by reducing the chronic inflammation that surrounds your affected joints. MSM is broken down by your liver into metabolites, including sulfur, which has a stimulatory effect on your vascular system, causing vasodilation, or an increase in the circumference of your blood vessels, similar to the effect of aspirin. An increase in blood flow and oxygen delivery promotes healing in tissues damaged by arthritis, by removing the inflammation that is inhibiting your body's natural healing process.

- **MSM, Autophagy, and Anti-Aging**

Autophagy was discovered in 2016 by a Japanese scientist. This is a process whereby your cells are recycling damaged cell parts, and getting rid of pathogenic microbes, such as mold, viruses, fungus, bacteria and candida. Autophagy is the ultimate anti-aging strategy. Each cell has mini-garbage disposals, called the lysosomes. These clear out the trash and send the particles to the liver for either fuel or making NEW parts. Using MSM turns this system on, and puts it super efficiency. This autophagy process can also be aided, to a lessor extent, by niacin, vitamin D3, olive oil, coconut oil, green tea, intermittent fasting, ketogenic diets, and exercise among other things. This is part of how, eating healthy and living healthy, optimizes body function.

RA Research

According to "The Miracle of MSM: The Natural Solution for Pain," by Dr. Stanley Jacob, a professor at Oregon Health Sciences University, if you have a sulfur deficiency, your risk of developing arthritis increases. After administering MSM to approximately 18,000 patients, Dr. Jacob concludes that MSM supplementation can improve symptoms of both rheumatoid arthritis and osteoarthritis. According to an article published in the Jan.-Feb. 2003 issue of "Anticancer Research," investigators found that, like aspirin, MSM exhibits anti-inflammatory effects.

Sources

MSM can be found in numerous foods, including those high in protein, such as meat, poultry, fish and eggs. It can also be found in milk, coffee, seafood and chocolate. It is also available as a supplement. There is no recommended daily allowance for MSM, but doses between 2 g and 6 g are common. As MSM occurs naturally in many foods it is believed to be safe. When given to laboratory rats at five to seven times the recommended dosage for humans, no adverse effects were noted after 90 days.

Dosing

According to Drugs.com, MSM is typically taken in 2 to 3 divided doses for a total of 2 to 6 g per day. The optimal dosage for MSM for the treatment of arthritis and other conditions has not been clearly established. According to eMedTV.com, some studies using MSM for arthritis have shown effectiveness when taking as little as 500 mg per day, while other studies indicate that 2 g twice per day for a total of 4 g is more effective. Consult with your doctor about MSM to see what dosage is right for you.

Precautions

MSM is considered to be one of the least toxic biological substances, according to Life Extension. MSM supplementation may occasionally have some side effects, which may be alleviated in severity by simply lowering the dosage. MSM supplementation may result in upset stomach or headache.

Many times reactions are due to detoxification effects and lowering the dose, for a time, will lesson or eliminate negative effects. In essence detoxifying slower corrects the issue. Due to a lack of research, you should not use MSM if you are pregnant or breastfeeding.

With limited clinical research on MSM comes a corresponding lack of quality information on side effects, according to eMedTV. However, side effects appear unlikely. Those reported in studies with humans, such as nausea, diarrhea, headache and fatigue, *were just as common in participants taking a placebo*.

Animal studies have found no toxicity for MSM, according to Drugs.com. Even when rats were fed up to 7 times the amount recommended for humans, no adverse events occurred. A standard dose for arthritis and other joint conditions is 2 to 6 g per day in 2 or 3 divided doses.

Sulfa allergy

It is commonly thought that people who are allergic to sulfa drugs might be allergic to sulfur containing products. This is not true. People with an allergy to "sulfa" react to the sulfonamide in some antibiotics and related drugs. They do not react to elemental or organic sulfur. We currently have no information for SULFUR Interactions

Contamination

Because the U.S. Food and Drug Administration does not regulate supplements as strictly as it does medications, some methylsulfonylmethane supplements could be contaminated with other substances and may not contain the amount of methylsulfonylmethane listed on the label. Buying only from reputable manufacturers can ensure that you avoid this problem, notes eMedTV.

Contamination is not a concern with MSM made in the USA and distilled 4 times for purity, as sold at IHHS Health& Wellness.

IHHS-HEALTH & WELLNESS CENTER
1607 SO. H STREET
BAKERSFIELD, CA 93304
(661) 837-0453 ~ FAX (661) 837-0560
The Local People Serving You

From the Weston Price foundation by Dr. Stephanie Seneff PhD. for an in-depth scientific understanding of MSM and sulfur use In the body.
https://www.westonaprice.org/health-topics/abcs-of-nutrition/sulfur-deficiency/

Sulfur Deficiency

JULY 2, 2011 BY STEPHANIE SENEFF, PHD

A Possible Contributing Factor in Obesity, Heart Disease, Alzheimer's and Chronic Fatigue

Obesity is quickly becoming the number one health issue confronting America today, and has also risen to epidemic proportions worldwide. Its spread is associated with the adoption of a Western-style diet. However, I believe that the widespread consumption of food imports produced by U.S. companies plays a crucial role in the rise in obesity worldwide. Specifically, these "fast foods" typically include heavily processed derivatives of corn, soybeans and grains, grown on highly efficient mega-farms. Furthermore, I will argue in this essay that one of the core underlying causes of obesity may be sulfur deficiency.

Sulfur is the eighth most common element by mass in the human body, behind oxygen, carbon, hydrogen, nitrogen, calcium, phosphorus and potassium. The two sulfur-containing amino acids, methionine and cysteine, play essential physiological roles throughout the body. However, sulfur has been consistently overlooked by those addressing the issues of nutritional deficiencies. In fact, the National Academy of Sciences has not even assigned a minimum daily requirement (MDR) for sulfur. One consequence of sulfur's limbo nutritional status is that it is omitted from the long list of supplements that are commonly artificially added to popular foods like cereal.

UNAPPRECIATED DEFICIENCIES

Sulfur is found in a large number of foods, and, as a consequence, it is assumed that almost any diet would meet the minimum daily requirements. Excellent sources are eggs, onions, garlic, and leafy dark green vegetables like kale and broccoli. Meats, nuts, and seafood also contain sulfur. Methionine, an essential amino acid, is found mainly in egg whites and fish. A diet high in grains like bread and cereal is likely to be deficient in sulfur. Increasingly, whole foods such as corn and soybeans are disassembled into component parts with chemical names, and then reassembled into heavily processed foods. Sulfur is lost along the way, and so is the awareness that this loss matters.

Experts have recently become aware that sulfur depletion in the soil creates a serious deficiency for plants,[17] brought about in part by improved efficiency in the U.S. agricultural industry, which has steadily consolidated into highly technologized mega-farms.

It is estimated that humans obtain about ten percent of their sulfur supply from drinking water. Remarkably, people who drink soft water have an increased risk of heart disease compared to people who drink hard water.[2] Many possible reasons have been suggested for why this might be true, and just about every trace metal has been considered as a possibility.[3] However, I believe that the real reason may simply be that hard water is more likely to contain sulfur.

SULFUR AND OBESITY RATES

The ultimate source of sulfur is volcanic rock, mainly basalt, spewed up from the earth's core during volcanic eruptions. It is generally believed that humans first evolved in the African rift zone, a region that would have enjoyed an abundance of sulfur due to the heavy volcanic activity there.

The three principal suppliers of sulfur to the Western nations are Greece, Italy and Japan. These three countries also enjoy low rates of heart disease and obesity and increased longevity. In the United States, Oregon and Hawaii, two states with significant volcanic activity, have among the lowest obesity rates in the country. By contrast, the highest obesity rates are found in the midwest and in southern farm country: the epicenter of the modern agricultural practices (mega-farms) that lead to sulfur depletion in the soil. Among all fifty states, Oregon has the lowest childhood obesity rates.

Hawaii's youth are faring less well than their parents, however: while Hawaii ranks as the fifth from the bottom in obesity rates, its children aged ten through seventeen weigh in at number thirteen. As Hawaiians have recently become increasingly dependent on food imports from the mainland, they have suffered accordingly with increased obesity problems.

In her recently published book, *The Jungle Effect*,[25] Dr. Daphne Miller devotes a full chapter to Iceland in which she struggles to answer the question of why Icelanders enjoy such remarkably low rates of depression, despite living at a northern latitude, where one would expect a high incidence of Seasonal Affective Disorder. She points out, furthermore, their excellent health record in other key areas: "When compared to North Americans, they have almost half the death rate from heart disease and diabetes, significantly less obesity, and a greater life expectancy. In fact, the average life span for Icelanders is amongst the longest in the world." While she proposes that their high fish consumption, with associated high intake of omega-3 fats, may plausibly be the main beneficial factor, she puzzles over the fact that former Icelanders who move to Canada and also eat lots of fish do not also enjoy the same decreased rate of depression and heart disease.

In my view, the key to Icelanders' good health lies in the string of volcanoes that make up the backbone of the island, which sits atop the mid-Atlantic ridge crest. Dr. Miller pointed out that the mass exodus to Canada was due to extensive volcanic eruptions in the late 1800s, which blanketed the highly cultivated southeast region of the country. This means, of course, that the soils today are highly enriched in sulfur. The cabbage, beets and potatoes that are staples of the Icelandic diet are likely providing far more sulfur to Icelanders than their counterparts in the American diet provide.

TWO MYSTERIOUS MOLECULES

Now comes the difficult question: why does sulfur deficiency lead to obesity? The answer, like much of biology, is complicated, and part of what I theorize is conjecture.

Sulfur is known as a healing mineral, and a sulfur deficiency often leads to pain and inflammation associated with various muscle and skeletal disorders. Sulfur plays a role in many biological processes, one of which is metabolism. It is present in insulin, the essential hormone that promotes the utilization of sugar derived from carbohydrates for fuel in muscle and fat cells. However, my extensive literature search has led me to two mysterious molecules found in the blood stream and in many other parts of the body: vitamin D_3 sulfate and cholesterol sulfate.[35]

Upon exposure to the sun, the skin synthesizes vitamin D_3 sulfate, a form of vitamin D that, unlike unsulfated vitamin D_3, is water soluble. As a consequence, it can travel freely in the blood stream rather than encapsulated inside LDL (the so-called "bad" cholesterol) for transport.[1] The form of vitamin D that is present in both human milk[19] and raw cow's milk[2] is vitamin D_3 sulfate (pasteurization destroys it in cow's milk).

Cholesterol sulfate is also synthesized in the skin, where it forms a crucial part of the barrier that keeps out harmful bacteria and other microorganisms such as fungi.[35] Cholesterol sulfate regulates the gene for a protein called profilaggrin, by interacting like a hormone with the nuclear receptor ROR-alpha. Profilaggrin is the precursor to filaggrin, which protects the skin from invasive organisms.[31,24] A deficiency in filaggrin is associated with asthma and arthritis. Therefore, cholesterol sulfate plays an important role in protection from asthma and arthritis. This explains why sulfur is a healing agent.

Like vitamin D_3 sulfate, cholesterol sulfate is also water-soluble, and it too, unlike cholesterol, does not have to be packaged up inside LDL for delivery to the tissues.

Here I pose the interesting question: where do vitamin D_3 sulfate and cholesterol sulfate go once they are in the blood stream, and what role do they play in the cells? Surprisingly, as far as I can tell, nobody

knows. It has been determined that the sulfated form of vitamin D_3 is strikingly ineffective for calcium transport, the well-known "primary" role of vitamin D_3.[29] However, vitamin D_3 clearly has many other positive effects (it seems that more and more are being discovered every day), and these include a role in cancer protection, increased immunity against infectious disease, and protection against heart disease. Researchers don't yet understand how it achieves these benefits, which have been observed empirically but remain unexplained physiologically. However, I strongly suspect it is the sulfated form of the vitamin that instantiates these benefits, and my reasons for this belief will become clearer in a moment.

One very special feature of cholesterol sulfate, as opposed to cholesterol itself, is that it is very agile: due to its polarity it can pass freely through cell membranes, almost like a ghost.[30] This means that cholesterol sulfate can easily enter a fat or muscle cell. I am developing a theory which at its core proposes an essential role for cholesterol sulfate in the metabolism of glucose for fuel by these cells. Below, I will show how cholesterol sulfate may be able to protect fat and muscle cells from damage due to exposure to glucose, a dangerous reducing agent, and to oxygen, a dangerous oxidizing agent. I will further argue that, with insufficient cholesterol sulfate, muscle and fat cells become damaged, and as a consequence become glucose intolerant, unable to process glucose as a fuel. This happens first to muscle cells but eventually to fat cells, as well. Fat cells become storage bins for fats to supply fuel to the muscles, because the muscles are unable to utilize glucose as fuel. Eventually, fat cells also become too disabled to release their stored fats. Fatty tissue then accumulates on the body.

SULFUR AND GLUCOSE METABOLISM

In order to understand my theory, you will need to know more about glucose metabolism. Skeletal muscle cells and fat cells break down glucose in the presence of oxygen in their mitochondria, and in the process they produce ATP, the basic energy currency of all cells. A glucose transporter called GLUT4 is present in the cytoplasm of muscle cells, and it migrates to the cell membrane upon stimulation by insulin. GLUT4 essentially acts as a key that unlocks the door, letting glucose into the cell, but, like a key, it only works when it's inserted in the membrane.

Both glucose and oxygen, unless they are carefully managed, can cause harm to the cell's proteins and fats. The glucose enters the cell within special cholesterol-rich sites in the cell wall called lipid rafts.16 This is likely orchestrated to protect the cell wall from damage, because extra cholesterol allows the vulnerable lipoproteins in the cell wall to pack more tightly and reduce their risk of exposure. In muscle cells, myoglobin is able to store additional oxygen, bound to an iron molecule safely sequestered in an interior cavity within the myoglobin protein.

Sulfur is a very versatile molecule, because it can exist in several distinct oxidative states, ranging from +6 (in the sulfate radical) to -2 (in hydrogen sulfide). Glucose, as a powerful reducing agent, can cause significant glycation damage to exposed proteins, leading to the formation of Advanced Glycation End Products (AGE's) that are extremely destructive to health: they are believed to be a major contributor to heart disease risk.[4] I hypothesize that, if sulfur (+6) is made available to glucose as a decoy, the glucose will be diverted into reducing the sulfur rather than glycating some vulnerable protein such as myoglobin.

In searching the Web, I came across an article written in the 1930s about the striking ability of iron sulfate, in the presence of the oxidizing agent hydrogen peroxide, to break down starch into simple molecules, even in the absence of any enzymes to catalyze the reaction.[5] The article pointedly mentioned that iron works much better than other metals, and sulfate works much better than other anions. In the human body, starch is first converted to glucose in the digestive system. The muscle and fat cells only need to break down glucose. Thus, their task is easier, because the iron sulfate is now starting from an intermediate breakdown product of starch rather than from starch itself.

Where would the iron sulfate come from? It seems to me that the cholesterol sulfate, having hopped across the cell membrane, could transfer its sulfate radical to the myoglobin, whose iron molecule could provide the other half of the formula. In the process, the sulfur molecule's charge would be driven down from +6 to -2, releasing energy and absorbing the impact of the reducing effects of glucose, and therefore serving as a decoy to protect the proteins in the cell from glycation damage.

When the cell is exposed to insulin, its mitochondria are triggered to start pumping both hydrogen peroxide and hydrogen ions into the cytoplasm, essentially gearing up for the assault by glucose. If cholesterol sulfate enters the cell alongside the glucose, then all the players are available.

I conjecture that cholesterol sulfate is the catalyst that seeds the lipid raft. Iron sulfate is then formed by bonding the iron in the heme unit in myoglobin to a sulfate ion provided by cholesterol sulfate. The cholesterol is left behind in the cell wall, thus enriching the newly forming lipid raft with cholesterol. The hydrogen peroxide, provided by the mitochondria upon insulin stimulation, catalyzes the dissolution of glucose by the iron sulfate. The pumped hydrogen can pair up with the reduced sulfur (S-2) to form hydrogen sulfide, a gas that can easily diffuse back across the membrane for a repeat cycle. The oxygen that is released from the sulfate radical is picked up by the myoglobin, sequestered inside the molecule for safe travel to the mitochondria. Glucose breakdown products and oxygen are then delivered to the mitochondria to complete the process, which ends with water, carbon dioxide and ATP, all while keeping the cell's cytoplasmic proteins safe from glucose and oxygen exposure.

If I'm right about this role for cholesterol sulfate both in seeding the lipid raft and in providing the sulfate ion, then this process breaks down miserably when cholesterol sulfate is not available. First of all, the lipid raft is not formed. Without the lipid raft, the glucose can not enter the cell. Intense physical exercise can allow glucose to enter the muscle cells even in the absence of insulin.[27]However, this will lead to dangerous exposure of the cell's proteins to glycation (because there is no iron sulfate to degrade the glucose). Glycation interferes with the proteins' ability to perform their jobs, and leaves them more vulnerable to oxidation damage. One of the important affected proteins would be myoglobin: it would no longer be able to effectively carry oxygen to the mitochondria. Furthermore, oxidized myoglobin released into the blood stream by crippled muscle cells leads to painful and crippling rhabdomyolysis, and possible subsequent kidney failure. This explanation accounts for the observation that sulfur deficiency leads to muscle pain and inflammation.

METABOLIC SYNDROME

The metabolic syndrome is a term used to encapsulate a complex set of markers associated with increased risk to heart disease. The profile includes (1) insulin resistance and dysfunctional glucose metabolism in muscle cells; (2) excess triglycerides in the blood serum; (3) high levels of LDL, particularly small dense LDL, the worst kind; (4) low levels of HDL (the "good" cholesterol) and reduced cholesterol content within the individual HDL particles; (5) elevated blood pressure; and (6) obesity, particularly excess abdominal fat. I have argued previously that this syndrome is brought on by a diet that is high in empty carbohydrates (particularly fructose) and low in fats and cholesterol, along with a poor vitamin D status.[35] While I still believe that all of these factors are contributory, I would now add another factor as well: insufficient dietary sulfate.

I have described in a previous essay my interpretation of obesity as a condition driven by a need for abundant fat cells to convert glucose to fat because the muscle cells are unable to efficiently utilize glucose as fuel. With sulfur deficiency comes the answer as to why muscle cells would be defective in glucose management: they can't come up with enough cholesterol sulfate to seed the lipid raft needed to import the glucose.

An alternative way to overcome a muscle cell's defective glucose metabolism is to exercise vigorously, so that the generated AMPK (an indicator of energy shortage) induces the GLUT4 to migrate to the membrane even in the absence of insulin.[27] Once the glucose is inside the muscle cell, however, the iron-sulfate mechanism just described is dysfunctional, both because there's no cholesterol sulfate and because there's no hydrogen peroxide. Additionally, with intensive exercise there's also a reduced supply of oxygen, so the glucose must be processed anaerobically in the cytoplasm to produce lactate. The lactate is released into the blood stream and shipped to the heart and brain, both of which are able to use it as fuel. But the cell membrane remains depleted in cholesterol, and this makes it vulnerable to future oxidative damage.

Another way to compensate for defective glucose metabolism in the muscle cells is to gain weight. Fat cells must now convert glucose into fat and release it into the blood stream as triglycerides, to fuel the muscle cells. In the context of a lowfat diet, sulfur deficiency exacerbates the problem. Sulfur deficiency interferes with glucose metabolism, so it's a much healthier choice simply to avoid glucose sources (carbohydrates) in the diet; i.e. to adopt a very low-carb diet. Then the fat in the diet can supply the muscles with fuel, and the fat cells are not burdened with having to store up so much reserve fat.

Insulin suppresses the release of fats from fat cells.[32] This forces the fat cells to flood the bloodstream with triglycerides when insulin levels are low, that is, after prolonged periods of fasting, such as overnight. The fat cells must dump enough triglyceride into the bloodstream during fasting periods to fuel the muscles when the dietary supply of carbohydrates keeps insulin levels elevated, and the release of fats from the fat cells is repressed. As the dietary carbs come in, blood sugar levels rise dramatically because the muscle cells can't utilize them.

The liver also processes excess glucose into fat, and packages it up into LDL, to further supply fuel to the defective muscle cells. Because the liver is so preoccupied with processing glucose and fructose into LDL, it falls behind on the generation of HDL, the "good" cholesterol. So the result is elevated levels of LDL, triglycerides, and blood sugar, and reduced levels of HDL, four key components of the metabolic syndrome.

The chronic presence of excess glucose and fructose in the blood stream leads to a host of problems, all related to glycation damage of blood stream proteins by glucose exposure. One of the key proteins that gets damaged is the apolipoprotein, apoB, which is encased in the membrane of the LDL particles. Damaged apoB inhibits the ability of LDL to efficiently deliver its contents (fat and cholesterol) to the tissues. Fat cells again come to the rescue, by scavenging the broken LDL particles (through a mechanism that does not require apoB to be healthy), taking them apart, and extracting and refurbishing their cholesterol. In order to function properly, the fat cells must have intact apoE, an antioxidant that cleans up oxidized cholesterol and transports it to the cell membrane for delivery to HDL particles.

FAT CELLS, MACROPHAGES, AND ATHEROSCLEROSIS

While diligently converting glucose to stored fats, the fat cells are awash in glucose, which damages their apoE through glycation.[20] Once their apoE is damaged, they can no longer transport cholesterol to the membrane. Excess cholesterol accumulates inside the fat cells and eventually destroys their ability to synthesize proteins. Concurrently, their cell membranes become depleted in cholesterol, because they can no longer deliver it to the membrane.[34] A fat cell that has deteriorated to this degree has no choice but to die: it sends out distress signals that call in macrophages. The macrophages essentially

consume the dysfunctional fat cell, wrapping their own membrane around the fat cell's membrane that is now barely able to hold its contents inside.[8]

Macrophages are also principal players in the fatty streaks that appear along the sides of major arteries leading to the heart, and are associated with plaque build-up and heart disease. In a fascinating set of experiments, Ma and others[22] have shown that the sulfate ion attached to oxidized forms of cholesterol is highly protective against fatty streaks and atherosclerosis.

In a set of in-vitro experiments, they demonstrated diametrically opposite reactions from macrophages to 25-hydroxyl cholesterol (25-HC) versus its sulfoconjugate 25-hydroxyl cholesterol sulfate (25-HC3S). Whereas 25-HC present in the medium causes the macrophages to synthesize and store cholesterol and fatty acids, 25-HC3S has the exact opposite effect: it promotes the release of cholesterol to the medium and causes fat stores to shrink. Furthermore, while 25-HC added to the medium led to apoptosis and cell death, 25-HC3S did not. I suggest that the sulfate radical is essential for the process that feeds cholesterol and oxygen to the heart muscle.

MUSCLE WASTING DISEASES

I recently came upon a remarkable article in a 1997 issue of FASEB[11] which develops a persuasive theory that low blood serum levels of two sulfur-containing molecules are a characteristic feature of a number of disease conditions. All of these diseases are associated with muscle wasting, despite adequate nutrition. The authors have coined the term "low CG syndrome" to represent this observed profile, where "CG" stands for the amino acid "cysteine," and the tripeptide "glutathione," both of which contain a sulfhydryl radical "-S-H" that is essential to their function. Glutathione is synthesized from the amino acids cysteine, glutamate and glycine, and glutamate deficiency figures into the disease process as well, as I will discuss later.

The list of disease conditions associated with low CG syndrome is surprising and very revealing: HIV infection, cancer, major injuries, sepsis (blood poisoning), Crohn's disease (irritable bowel syndrome), ulcerative colitis, chronic fatigue syndrome and athletic over-training.

This paper fills in some missing holes in my theory, but the authors never suggest that sulfur deficiency might actually be a precursor to the development of low CG syndrome. I think that, particularly with respect to Crohn's disease, chronic fatigue syndrome and excessive exercise, sulfur deficiency may precede and provoke the muscle wasting phenomenon. The biochemistry involved is complicated, but I will try to explain it in as simple terms as possible.

I will use Crohn's disease as my primary focus for discussion: an inflammation of the intestines, associated with a wide range of symptoms, including reduced appetite, low-grade fever, bowel inflammation, diarrhea, skin rashes, mouth sores and swollen gums. Several of these symptoms suggest problems with the interface between the body and the external world, for example, a vulnerability to invasive pathogens. I mentioned before that cholesterol sulfate plays a crucial role in the barrier that keeps pathogens from penetrating the skin. It logically plays a similar role everywhere there is an opportunity for bacteria to invade, and certainly a prime opportunity is available at the endothelial barrier in the intestines. Thus, I hypothesize that the intestinal inflammation and low-grade fever are due to an overactive immune system, necessitated by the fact that pathogens have easier access when the endothelial cells are deficient in cholesterol sulfate. The skin rashes and mouth and gum problems are a manifestation of inflammation elsewhere in the barrier.

Ordinarily, the liver supplies cholesterol sulfate to the gall bladder, where it is mixed into bile acids, and subsequently released into the digestive system to assist in the digestion of fats. If a person consistently eats a lowfat diet, the amount of cholesterol sulfate delivered to the digestive system from the liver will be reduced. This will logically result in a digestive system that is more vulnerable to invasion by pathogens.

The sulfate that's combined with cholesterol in the liver is synthesized from cysteine, therefore insufficient bioavailability of cysteine will lead to a reduced production of cholesterol sulfate by the liver. This will, in turn, make it difficult to digest fats, likely, over time, compelling the person to adhere to a lowfat diet. Whether lowfat diet or sulfur deficiency comes first, the end result is a vulnerability to infective agents in the intestines, with a consequential heightened immune response.

Dröge[11] further discusses how a reduction in the synthesis of sulfate from cysteine in the liver leads to increased compensatory activity in another biological pathway in the liver, one that converts glutamate to arginine and urea. Glutamate is highly significant because it is produced mainly by the breakdown of amino acids (proteins in the muscles), for example, by muscle wasting. The muscle cells are triggered to cannibalize themselves in order to provide adequate glutamate to the liver, mainly, in my view, in order to generate enough arginine to replace the role of sulfate in muscle glucose metabolism. (These activities in the liver and muscles are circular and mutually supportive.)

Arginine is the major source of nitric oxide (NO) and NO is the next best thing for muscle glucose metabolism in the absence of cholesterol sulfate. NO is a poor substitue for SO_4^{-2}, but it can function in some of the missing roles. As you will recall, I propose that cholesterol SO_4^{-2}accomplishes a number of important things in muscle cells: it delivers oxygen to myoglobin, it supplies cholesterol to the cell membrane, it helps break down glucose, it protects the cell's proteins from glycation and oxidation damage, and it provides energy to the cell. NO can help in reducing glycation damage, as nitrogen can

be reduced from +2 to 0 (whereas sulfur reduces from +6 to -2). It also provides oxygen, but it is unable to transfer the oxygen directly to myoglobin by binding with the iron molecule, as is the case for sulfate. NO does not supply cholesterol, so cholesterol deficiency remains a problem, leaving the cell's proteins and fats more vulnerable to oxidative damage. Furthermore, NO itself is an oxidizing agent, so myoglobin becomes disabled, due to both oxidation and glycation damage. The muscle cell, therefore, engages in mitochondrial oxidation of glucose at its own peril: better to revert to anaerobic metabolism of glucose to decrease the risk of damage. Anaerobic metabolism of glucose results in a build-up of lactic acid, which, as explained in Dröge[11] further enhances the need for the liver to metabolize glutamate, thus augmenting the feedback loop.

Furthermore, if I'm right about cholesterol sulfate seeding lipid rafts, then, with a cholesterol sulfate deficiency, the entry of both glucose and fat into the muscle cell is compromised. This situation leaves the cell with little choice but to exploit its internal proteins as fuel, manifested as muscle wasting.

In summary, a number of different arguments lead to the hypothesis that sulfur deficiency causes the liver to shift from producing cholesterol sulfate to producing arginine (and subsequently nitric oxide). This leaves the intestines and muscle cells vulnerable to oxidation damage, which can explain both the intestinal inflammation and the muscle wasting associated with Crohn's disease.

The immune system depends upon abundant cholesterol to defend against severe stress. I have previously argued that high serum cholesterol is protective against sepsis. It is worth repeating here the abstract from Critical Care,[38] which studied changes in blood cholesterol levels following trauma, infection and multiple organ failure: "Hypocholesterolemia is an important observation following trauma. In a study of critically ill trauma patients, mean cholesterol levels were significantly lower (119 ± 44 mg/dl) than expected values (201 ± 17 mg/dl). In patients who died, final cholesterol levels fell by 33 percent versus a 28 percent increase in survivors. Cholesterol levels were also adversely affected by infection or organ system dysfunction."

Thus, many of these conditions/diseases that lead to muscle wasting may do so because cholesterol (and therefore cholesterol sulfate) is depleted from the blood serum. This results in the same feedback loop between the liver and the muscles that I discussed with regard to C rohn's disease. I think it's plausible that the muscle wasting associated with all of these conditions is caused by this same feedback mechanism.

I have discussed the role cysteine plays in providing sulfate to the liver. But what is the role of glutathione, the other sulfur-containing protein that's depleted in low GC syndrome? Muscle cells ordinarily contain significant levels of glutathione, and its depletion leads to mitochondrial damage.[23] Patients undergoing surgical trauma have been found to exhibit reduced glutathione levels in

their skeletal muscles.[21] It is tempting to speculate that cholesterol sulfate provides the sulfur needed for glutathione synthesis, so that the deficiency would be explained by the reduced availability of cholesterol following the immune system's heightened response to surgical trauma. Glutathione is a potent antioxidant, so its deficiency will further contribute to dysfunction of the muscle cell's mitochondria, therefore greatly impairing its energy supply.

There is a growing awareness that glutathione deficiency may play a role in many diseases. Whether the problems that arise are just due to insufficient supply of the glutathione molecule itself, or whether a more general sulfur deficiency is the root cause, is perhaps hard to say, but provocative nonetheless.

IN CONCLUSION

Modern lifestyle practices conspire to induce major deficiencies in cholesterol sulfate and vitamin D_3 sulfate. We are encouraged to actively avoid sun exposure and to minimize dietary intake of cholesterol-containing foods. We are encouraged to consume a high-carbohydrate, lowfat diet which, as I have argued previously,[34] leads to impaired cholesterol uptake in cells. Fortunately, correcting these deficiencies at the individual level is easy and straightforward. If you just throw away the sunscreen and eat more eggs, those two steps alone may greatly increase your chances of living a long and healthy life.