Oxidative Stress- the root cause of inflammation

What is oxidative stress?

Maybe you have heard about how important it is to include lots of fruits and vegetables in your diet. Maybe you have heard that it's important to take antioxidants as supplements. Maybe you have heard about "super antioxidants", "super foods" or supplements that promise to make you look and feel younger. Our global society is full of advertisements—but a bit short on explanations! In this chapter, you will see why antioxidants—both the natural ones in our bodies and the supplements are so important.

In nearly all of the essential biochemical reactions going on in our bodies there are transfers of electrons (negatively charged particles). When an electron, with a negative charge, is transferred to a molecule, that molecule is said to be **RED**uced—because it becomes more negative. When a substance loses an electron, it becomes more positive, and is referred to as being **OX**idized. This category of biochemical reaction is called a **REDOX** reaction and is going on constantly in every cell of our bodies. These reactions are primarily occurring in the mitochondria. The mitochondria are featured in many basic biology classes as the "powerhouse" or the "battery packs" of the cell. The function of the mitochondria is to release the energy found in foods into a form that our cells can use—these functions come under the category of cellular respiration—in other words, this is how our cells "breathe"!

During these redox reactions, there are by-products called free radicals—a free radical has one extra electron (unpaired electron) —and that makes it very unstable and very reactive. There are various types of free radicals—there are the Reactive Oxygen Species (ROS) and the Reactive Nitrogen Species (RNS) and others. Perhaps, you've heard the phrase "nature abhors a vacuum"? Well, nature doesn't much like an unpaired electron either—not one bit—and that is why the free radicals are so unstable. They need to "grab" an electron—and they will from any molecule nearby. This is what causes damage because the free radicals grab an electron from DNA, a nearby protein or lipid/fatty acid…or anything else it can! In the process of grabbing the electron, the free radical damages the DNA, the protein or the lipid/fatty acid, and THAT damages the cells, the tissues and the organs. The mitochondria can be particularly damaged because so many of the redox reactions take place there. When enough mitochondria get damaged, not enough energy is produced and even more damage results. The "powerhouse" has been switched off—there's no more "juice" in the battery! It is the build-up of this oxidative stress that we call inflammation. Our bodies have a great ability to compensate and fix the damage, but, eventually, we (and our cells) just can't compensate anymore and the inflammatory response takes over. The oxidative stress our cells and tissues undergo can in the end, result in a large number of different diseases—including PCOS,[1, 2, 3] heart disease,[4,5.6] diabetes,[7, 8, 9]

metabolic syndrome,[1,10] infertility,[9,11,12,13] and obesity.[14, 15, 16] Which condition seems to depend on many factors, including your genetics, your exposure to various chemicals and your medical history. It is important to remember, that free radicals DO perform vital functions in the body—in killing off viruses and bacteria, in the immune response and in other metabolic processes. [17,18,19] Free radicals are even thought to be involved in the inevitable process of aging! One theory proposes that aging is the accumulation of the damaging effects of free radicals.[20, 21]

So, while the production of free radicals is a natural and even advantageous process, when it goes out of control, it can be a serious problem. Nature, as it tends to do, though, also provides a natural control mechanism for all these free radicals.

There are a number of systems—antioxidant systems—that normally control and "mop up" the free radicals. Some of the most important antioxidants naturally found in the body are glutathione, CoQ_{10}, vitamins A, C and E, niacin, ferritin and the trace mineral selenium, among others.[22] In addition, the omega-3 fish oils that you've probably heard so much about also protect against the damaging effects of free radicals and by doing so, reduce inflammation. So, under healthy conditions, these natural antioxidants are supposed to prevent just the sort of damage described earlier. Even more impressive is the fact that many of the natural antioxidants produced by the body can be recycled, and they are very efficient at it. [23,24,25, 26,27,28] But, while these natural antioxidants can be recycled, they can also be overwhelmed by free radicals, particularly once inflammatory conditions begin! Our environment contains many,many toxins, heavy metals and man-made synthetic substances that can promote oxidation and are known to be pro-inflammatory. [14,29,30] For example, among the cells of the immune system, there are cells which, when exposed to toxins in the air, tend to favor pro-inflammatory conditions, as opposed to those that fight infections—if these types of immune cells are stimulated often enough, asthma may result.[31] Fat cells tend to promote inflammation—being overweight can essentially be described as a "pro-inflammatory state"[32,33] Conditions such as sleep apnea, often seen in PCOS, is also seen as a "pro-inflammatory state"[34] The other chronic conditions seen in PCOS—metabolic syndrome, high blood pressure and diabetes are also pro-inflammatory states.[1-16]

But, why has chronic disease – and inflammation—become such an epidemic?[35,36] One idea to explain this is called the "nutrition transition" or the switch from a vegetable and fruit-based diet to one which is high in meat, sugar, saturated fats and salt.[37, 38,39] For example, an improved diet, tobacco cessation and increased physical activity rate could prevent up to 80% of cases of coronary artery disease and 90% of diabetes.[40] Other reasons cited for the increase in chronic diseases include tobacco use, increased stress, environmental toxins and a lack of exercise.[36-41] The increase in obesity—tied to all the other factors, of course, tends to be the single most common factor in chronic disease. [41]

So, what does all of this information have to do with PCOS? While we don't understand all the mechanisms of the development of PCOS, at the very heart of PCOS, is oxidative stress and

inflammation. As mentioned, every condition associated with PCOS, and PCOS itself has been found to be connected to high levels of oxidative stress and the resulting inflammation.

Now- what can we DO about it? One of the most important things that you can do is adopt an anti-inflammatory diet. Before we get into the types of foods that are anti-inflammatory, a word (or a few…) about omega-3 and omega-6 essential fatty acids is needed.

Essential fatty acids are a type of fatty acid that can't be made by your body and must be obtained from the foods you eat. There are many families of EFAs, but the most important for their effects on inflammation are the omega-3, omega-6 and the omega-9 fats (The main source of omega-9 fats, an anti-inflammatory fat, is olive oil.)

Omega-3 fats are used by the body to make substances that are ANTI-inflammatory (they reduce inflammation) while omega-6 fats tend to be funneled into substances that are PRO-inflammatory (they increase inflammation). The critical issue lies in the ratio of omega-3 and omega-6 fatty acids that we ingest. Omega-6 fats are very readily found in foods—most vegetable oils, for example. Omega 6 fats are also found in high amounts in meat—particularly red meat from cows raised on non-grass foods. The omega-3 fats, on the other hand are found mainly in fish, and many people don't have access to a lot of fish. So, the tendency in the last century has been for increased amounts of omega-6 fats relative to the omega-3 fats. It is this skewed ratio that is so very important that tips the balance towards more and more inflammation—the last century has also seen the rise of chronic diseases—some of which were never seen or exceedingly rare before![42,43,44,45]

Ancient humans used to consume roughly same amount of omega-3 and omega-6 fats—studies indicate they ate about a 1:1 ratio.[43] Modern humans consume over **15** times more omega-6 fats than omega-3 fats—a 15:1 ratio![46] In some countries, people consume **20** times more Omega-6 than Omega 3! In those countries where the ratio of omega-6 to omega-3 is over 4:1, there is a corresponding increase in chronic disease.[46] Ancient humans died from trauma and infections, but they did NOT die from chronic diseases.

So, the anti-inflammatory diet increases anti-inflammatory foods partly by increasing the amounts of omega-3 fats, often by supplementing with fish oils. Olive oil is also used extensively as the omega-9 fats in olive oil are anti-inflammatory as well. Other anti-inflammatory foods include fruits, berries and vegetables (especially the leafy green variety), nuts, brown rice, lean (free-range) poultry, wild-caught fish and seafood, soy and soy foods such as tofu and tempeh, legumes such as lentils and beans, green tea, fruit and vegetable juices and lots and lots of water! Lots of herbs and spices are anti-inflammatory as well—you can use them in your cooking to add flavor and variety. These herbs and spices include curcumin, ginger, paprika, dill, mint, thyme, marjoram, oregano, basil, rosemary, parsley, celery, onions and garlic. Organic food is highly recommended—or, you can grow your own vegetables! Simple, whole

foods, as pesticide and toxin free as you can find will not only reduce your inflammation, help you lose weight—but the process of cooking the food gives you control over what you eat and how you eat it—it empowers you to help you heal yourself!

We live in the world we live in—but we can also have the kind of control mentioned. It is a simple idea, yet not always so simple to incorporate into our lives, but the fact is, if eating like your grandparents did can give you such a big boost in health and vitality, well, it certainly makes it a more attractive and achievable goal!

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