# SAVE THE GORILLAS

by

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> **"The Committee on the Feeding of Laboratory Animals of the U. S. National Academy of Sciences - National Research Council recommends far more vitamin C for monkeys than the Food and Nutrition Board of the same U. S National Academy of Sciences - National Research Council recommends for human beings."** – Linus Pauling, *How to Live Longer and Feel Better* , 1986

The recent epidemic of heart disease among gorillas in zoos may have a simple solution. Biologically, the gorilla is similar to humans and other high order primates. This article concentrates on one startling similarity – the inability of primates to synthesize ascorbic acid commonly known as vitamin C. The great apes share a common genetic defect with humans – the inability to make the enzyme L-gulonolactone oxidase in the liver, an enzyme that would otherwise allow primates to convert the sugar glucose into ascorbic acid. Geneticists refer to this defect in primates as the GLO mutation. Two time Nobel prize-winning chemist Linus Pauling theorized that this defect is the cause of heart disease.

This deficiency in primate metabolism, the inability to synthesize ascorbic acid, is rare in the animal kingdom. Almost all other species such as lions, tigers, bears, dogs, cats, cows, chickens, elephants, etc. make their own vitamin C, and they make a lot every day. Wild animals generally make more vitamin C than domesticated animals (Levy, 2006). The species that make their own vitamin C share another trait; they do not suffer the same cardiovascular disease that afflicts the few species with the GLO defect such as humans, primates, and guinea pigs.

The gorilla community in the world's zoos is a microcosm of the human condition. The current epidemic of heart disease in the gorilla may provide scientists the means to clinically study Pauling's ideas – studies that so far have been lacking in humans. There is little reason to refrain from testing the Pauling ideas in gorillas. The mere fact that the great apes are succumbing to heart disease supports Pauling's theory. Should the two time Nobel prize winner Linus Pauling be right, then vitamin C supplements will solve the gorilla heart disease problem in a matter of weeks. If Linus Pauling is wrong, little or no harm can be expected from trying his nontoxic therapy, and the same logic applies to heart disease in humans.

## *Vitamin C Requirements of the Primates*

The species that are unable to make their own vitamin C require a small amount of this molecule in their diet to avoid a quick death from the deficiency disease scurvy. The Recommended Daily Allowance (RDA) of vitamin C for humans has been established at 60 milligrams. This small amount of vitamin C every day prevents outright death. However, Linus Pauling and others have argued that larger amounts put us in better health. Authorities on primates as published by subcommittees of the National Academy of Sciences recommend that primates in captivity receive large amounts of vitamin C daily for the best health.

> **. . . much effort has been devoted by the Subcommittee on Laboratory Animal Nutrition to finding the intakes of various nutrients that puts them in the best of health. These careful studies have led to the formulation of several, rather similar recommended diets for laboratory monkeys. The amount of ascorbic acid (vitamin C) in these diets lies in the range of 1.75 g per day to 3.50 g per day, scaled up to the 70 kg of body weight (in humans); the 1.75 g per day scaled from the prescription for rhesus monkeys and 3.50 g per day from that for squirrel monkeys. These monkeys weigh only a few kilograms, but there is little doubt that the need for ascorbic acid is proportional to body weight . . . .** – Linus Pauling, *How to Live Longer and Feel Better*, 1986

The additional amount of vitamin C in the diet that leads to the best of health in humans is controversial. The amount of ascorbic acid that other species synthesize can be used as a model. When adjusted for body weight, it has been determined that the amount of ascorbate produced by mammals ranges from an estimated 3,000 mg to more than 13,000 mg daily (Pauling, 1986). Nearly all species manufacture these copious amounts 24/7 out of the sugar glucose, and they make more vitamin C under stress. Glucose is present in the blood as carbohydrates are broken down during digestion into sugars.

Gorillas, like man, must obtain their vitamin C from the foods they eat. In 1970, the world-renowned scientist Linus Pauling argued that the vitamin C requirement of primates is an indicator of the level of vitamin C required for optimal health in humans. Writing in the *Proceedings of the National Academy of Sciences*, Pauling cited studies which determined that the gorillas would obtain 4.5 grams (4,500 mg) of vitamin C in the 40 to 50 pounds of food that they eat daily in their natural habitat (Pauling, 1970).

Pauling believed that chronically low levels of vitamin C, while not killing us, eventually results in various chronic maladies shared by many primates and also the guinea pig. These maladies are numerous and include all forms of cardiovascular disease, e.g. atherosclerosis, heart attack, and stroke.

Vitamin C expert and biochemist Irwin Stone, writing in his 1972 book *The Healing Factor: Vitamin C Against Disease*, outlines the vitamin C requirements of the few species that cannot make vitamin C that have been studied in captivity. Stone relates:

**From the "Committee on Animal Nutrition, Nutrient Requirements of Laboratory Animals" (1962) we find some startling figures. The recommended diet for the monkey - our closest mammalian relative - is 55 milligrams of ascorbic acid per kilogram of body weight or 3,830 milligrams of ascorbic acid per day for the average adult human. The daily amount suggested as adequate for the guinea pig varies depending upon which of two diets is selected and ranges from 42 to 167 milligrams per kilogram of body weight (based on a 300-gram guinea pig). This amounts to 2,920 milligrams to 11,650 milligrams per day for the average adult human.**

There is little debate, and there can be little doubt, that large amounts of vitamin C are normal for gorillas and that these large amounts put them in better health than smaller amounts. Careful studies have determined that the daily vitamin C recommendation for captive, non-human primates is 25 milligrams per kilogram of body weight (Portman 1970). As an example, if we apply this calculation to humans, i.e. 25 mg multiplied by 70 kg, we calculate the human daily requirement of vitamin C to be 1,750 mg, much higher than the 60 to 75-mg RDA.

Gorillas weigh considerably more than humans. According to the San Diego Zoo, *male gorillas generally weigh from****3*00 to 500 pounds (136 to 227 kilograms) and female gorillas weigh from 150 to 200 pounds (68 to 91 kilograms). If we apply the calculation to the smallest female and the largest male, the daily vitamin C range for the captive gorilla is from 1,700 mg (68 kg multiplied by 25 mg) for the female gorilla to 5,675 mg (227 kg multiplied by 25 mg) for the heaviest male gorilla.

## *Something Has Changed*

The fact that gorillas are suffering heart disease in greater number is evidence that something has changed about the gorilla conditions in zoos. It is unlikely that zookeepers would deliberately mistreat these animals, but they may be getting bad advice. Dietitians trained in the old-fashioned nutrition are giving bad advice to humans about vitamin C. Our cursory review of the zoological literature has provided an indication that so-called nutrition experts have argued that *less* vitamin C is required in certain primates than the amounts these animals would obtain in the wild. Some authorities have even advised that more vitamin C might possibly be harmful. This advice, related to iron intake, is bad advice. The *iron source* in the diet should be reduced, not the dietary intake of vitamin C.

If captive gorillas are receiving the same amount of vitamin C that zookeepers have long considered adequate, perhaps some new variable is present. The nonprofit Vitamin C Foundation is aware of several factors that reduce the bio-availability of vitamin C in humans, and it is safe to assume that these factors are at work in our genetic cousins. Either the animal food is not fresh (*meaning the highly reactive vitamin is lost*); the diet has been changed to include more processed foods ( *which would adversely affect cell membranes and thus vitamin C uptake to cells*); or the process of “evolution” in zoos is allowing more gorillas that would otherwise have died in the wild to survive and have

offspring.

A topic about the gorillas dying in captivity has been started at the Vitamin C Foundation online forum. The following posts from a zoo insider provide a clue about what may be happening to the great apes:

> I have worked in a small zoo and all the workers had fun sharing their soda with the matriarch spider monkey. She loved it and would throw a tantrum like a child until she got some. The other monkeys loved it as well. Their standard diet of monkey chow was supplemented with stale donuts, cakes, and bread from a local bakery and stale vegetables and fruit. Guess what food got eaten first? The cakes of course!!! Every animal from the wolves to the monkeys ate like that. The monkey chow would mostly be eaten by the monkeys on the low end of the pecking order because the stronger animals would fill up on the sweets.
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> I would believe that is standard practice with many zoos due to keeping food costs down. – *Chris, Vitamin C Foundation forum, http://www.vitamincfoundation.org/forum

Another poster at our forum relates his conversation with a veterinarian:

> A friend of mine, a vet, mentioned to me that these animals are fed refined carbohydrates. Gorillas wouldn't normally eat these rapidly digested carbs in the wild. So I guess the reason is the dramatic increase of processed foods in their diet. – Mica

## *How to Save the Gorillas*

A solution to the plight of captive gorillas may be as simple as providing our close cousins with vitamin C supplements. From our research we believe that restoring vitamin C metabolism in the captive gorilla is likely to clear up many other afflictions which appear in epidemic proportions in gorillas, such as *testicular atrophy* and infertility.

### Glucose-Ascorbate Antagonism

Improving the gorilla diet by making it more like what they would obtain from their natural habitat is important, albeit expensive. It is likely that the better (more natural) the diet, in both humans and gorillas, the less vitamin C is required for good health. Dr. John Ely, Professor Emeritus of Nutrition at Washington State University, developed his glucose-ascorbate antagonism theory (GAA) more than 30 years ago. It is known that most species can convert the sugar glucose into vitamin C in the liver or kidney. Vitamin C and glucose molecules are similar, and both molecules share a common insulin-mediated uptake into cells through the lipid-rich cellular membrane.

Dr. Ely suggests that high levels of sugar in the blood crowds out the vitamin, increasing the probability that glucose, rather than ascorbate (vitamin C), will enter cells. Dr. Ely calls this effect glucose-ascorbate antagonism. He cites evidence that reducing blood sugar levels increases the effectiveness of vitamin C supplements for fighting colds, for example. This theory would suggest that in addition to increasing the gorilla's vitamin C, perhaps by using vitamin C supplements or by adding vitamin C to their water, zookeepers would do well by their charges to eliminate any sugary foods that these animals are currently allowed to ingest.

## Cell Membrane Disruption by Trans Fatty Acids

Furthermore, Mr. Thomas Smith, http://www.healingmatters.com, has uncovered medical evidence that the condition commonly referred to as Type II diabetes is a disturbance of the cell membrane caused by eating processed foods that contain abnormal trans fatty acids. These processed fats interrupt normal cell membrane repair, and the net effect is that the insulin-mediated uptake of glucose from the blood into cells is reduced. Over time, glucose uptake is limited in billions of cells, leading to elevated blood sugar levels. Because vitamin C shares these common entryways into cells, if Smith is correct, many of the adverse effects associated with Type II diabetes are caused by vitamin C starvation in those cells with damaged membranes. This leads us to conclude that gorillas (and humans) should not be given highly processed foods such as donuts and pastries and that if they are, their vitamin C needs will increase considerably.

For more details on Mr. Smith's findings and the dangers in eating so-called trans fats, visit his Web site.

## Other Supplements

After the gorilla diet has been rectified and/or vitamin C supplements are being routinely provided, zookeepers may ask what other supplements might be good for their primate charges. The answer is *vitamin E*, *proline,*and perhaps the amino acid *lysine*.

## Lp(a) Binding Inhibitors

Twenty years ago scientists made an important discovery that only one form of cholesterol – Lp(a) – begins the process of forming atherosclerotic plaques in humans. Lp(a) is an ordinary cholesterol particle with a sticky apoprotein particle called /apo(a)/attached to its surface. Lp(a) does not come in a standardized size or mass; the apo(a) may attach to a

wide variety of low density lipoproteins during its formation in the liver. Essentially, all human blood contains Lp(a). However, there can be a thousand-fold range in its plasma concentrations between individuals. According to Pauling and others, high levels of Lp(a) are associated with high incidence of cardiovascular disease.

If the news reports describing the plight of gorillas in captivity are accurate, the cardiovascular disease that manifests in the gorilla is not identical to human cardiovascular disease. If true, this suggests that the primary precursor, the Lp(a) molecule that Pauling told us initiates the disease process, may have a different binding region in gorillas than the /lysine/binding region of human Lp(a). According to research available from the National Institutes of Health's online database MEDLINE, and as related in our recent book:

The rhesus monkey, like human beings, cannot make its own vitamin C. The Lp(a) found in rhesus monkeys, however, does not bind to lysine and has thus been designated as LBS-. The rhesus monkey's Lp(a) does have a "proline binding domain," and thus this peculiar form of Lp(a), LBS- binds to fibrinogen. – *O. Fonorow and S. Jewell, *Practicing Medicine Without A License? The Story of the Linus Pauling Therapy for Heart Disease*, 2008

Linus Pauling's therapy to reverse heart disease in humans consists of high dosages of nutritional substances he called *Lp(a) binding inhibitors*. These substances specifically target the Lp(a) molecules,making them less "sticky" and thus less likely to attach to the walls of damaged arteries. The Lp(a) binding inhibitors for humans include the non-toxic amino acid lysine to account for the lysine binding region in their Lp(a). It is unknown whether gorilla Lp(a) is LBS- or LBS+. If LBS-, we can infer that proline would be the active "Lp(a) binding inhibitor" in the gorilla, just as proline would be predicted to inactivate Lp(a) in the rhesus monkey. Until we know, both of these amino acids are non-toxic and thus harmless. Considering the serious problem facing zookeepers, it would be prudent to provide the gorillas with adequate amounts of both amino acids in addition to correcting vitamin C metabolism.

## Vitamin E

Vitamin E is an antioxidant vitamin that helps to recycle vitamin C in the body. Linus Pauling discusses in his 1986 book, *How to Live Longer and Feel Better*, the vitamin E research showing that this vitamin in humans prevents and lowers the risk of heart disease. The gorilla would obtain considerable vitamin E in its natural habitat. Thus, we may conclude that the gorilla would do well to receive more vitamin E. Zookeepers should consider foods with a high vitamin E content, or even vitamin E supplements.

**Gorillas Might Benefit from Products to Overcome Heart Disease, Also Known as *Chronic Scurvy***

The Vitamin C Foundation has approved an Lp(a) binding inhibitor intended for human consumption that is called ***Cardio-C***. *The product**contains vitamin C, lysine and proline without sugar or other fillers. Mixed with water it makes a drink that tastes like orange juice. This healthy soft drink might make this important supplementation easier in the gorilla. Tower Orthomolecular Laboratories offers a more complete product with vitamin E. Tower's ***Heart Technology*** is also a good-tasting nutritional drink mix without fillers or impurities.**Zookeepers can visit the following web sites ***http://www.vitamincfoundation.org*** and ***http://www.hearttechnology.com***for further information.

## *Conclusion*

The recent epidemic of heart disease among captive gorillas all over the world has led these authors to the supposition that gorillas are suffering from chronic scurvy. This supposition is easily tested, and zookeepers can determine whether giving vitamin C supplements to the gorillas will reverse their disease as Linus Pauling predicted it would in humans.

Gorillas have the same genetic defect (GLO) that is common among the high order primates. This defect prevents primates from making ascorbate in the liver. Therefore the gorilla, like humans, cannot make a single molecule and must obtain it from the diet to live.

In 1989 Dr. Linus Pauling and cardiologist Dr. Matthias Rath, building on the earlier work of the Canadian doctor Willis from the 1950s, identified chronically low levels of vitamin C in humans as the primary cause of heart disease. The Pauling vitamin C theory of heart disease has been dismissed *a priori* by medicine and for more than 20 years has never been clinically investigated by modern medical science.

If the Linus Pauling theory is valid, then the current heart disease epidemic in our primate cousins is caused by an interruption in their vitamin C metabolism. Importantly, Pauling's theory and therapy may finally be tested in the gorilla, leading to its wider adoption in humans. Not studying the Pauling therapy in humans or gorillas is inexcusable, given the breadth and depth of the science that has been available for 50 years regarding the connection between chronically low vitamin C and the gradual development of heart disease. Zookeepers have an obligation to at least try this simple solution. They should restore to the bloodstream the amount of vitamin C that these apes would maintain from foraging for food in their natural habitat.

When the human primate gets bad advice he is free to browse the Internet and learn how

to overcome the deficiency in metabolism. Gorillas held in captivity must obviously rely on the knowledge and judgment of their zookeepers to keep them healthy. Gorillas, humans, other high order primates, and the guinea pig are among the very few creatures that can suffer and die of the vitamin C deficiency disease scurvy, both chronic as well as acute. We urge zookeepers to provide gorillas in captivity with vitamin C. We also ask them to help us investigate the Linus Pauling therapy for cardiovascular disease in primates by keeping records and making them publicly available. If the authors can help in any way, we will make ourselves available.

## *More Information*

The Pauling theory and therapy reviewed in this article are detailed in a new book that describes the 50-year history of the vitamin C theory of heart disease, as well as the therapy for this condition invented by two time Nobel prize recipient Linus Pauling.

*Practicing Medicine Without A License? The Story of the Linus Pauling Therapy for Heart Disease*

By Owen Fonorow and Sally Snyder Jewell, 2008

More information is available at www.practicingmedicinewithoutalicense.com

We are interested in whether Pauling's advice can halt the epidemic of heart disease in gorillas. We encourage zookeepers to join the public Vitamin C Foundation forum, www.vitamincfoundation.org/forum, where they may ask questions and provide reports on their progress in curing the gorillas.

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