

Robert Crayhon: Some assert that too much protein, even beyond 60-70 grams per day, is bad for people, will damage the kidneys and liver and cause bone loss. Yet we find people groups around the world who eat a pound or more of meat per day and don't seem to have any of these problems. What does your research suggest?

Loren Cordain: Epidemiological studies have suggested that increased animal protein intake is associated with higher rates of osteoporotic fracture, and many metabolic trials have demonstrated increased urinary calcium losses with increased protein intake.

However, in order to firmly establish cause and effect, and hence proof, that a certain variable is responsible for a certain effect, scientists conduct intervention trials. To my knowledge intervention studies have not been able to show that a change from low/moderate to high protein intake increases that rate of kidney stones or bone loss in either humans or animals.

Stone age diets clearly were characterized by extremely high protein intakes by modern standards, yet bone robusticity and density (determined from fossil paleolithic humans) were greater than or equal to that of most modern humans despite the total absence of dairy products in stone age diets.

This seeming paradox (low calcium intake, high protein intake yet strong dense bones) may probably be explained by multiple factors. Stone age humans were more active than modern people and consequently the everyday work they did resulted in greater bone loading, which in turn can influence bone density.

Further, they lived outside most of the day so their sunshine exposure and hence vitamin D status would likely have been superior to most modern people who work indoors and get little sunshine exposure.

Lastly, and most importantly, the critical dietary factor influencing bone metabolism and hence osteoporosis is not calcium intake, nor calcium excretion, but rather calcium balance.

The acid base status of the total diet rather than calcium intake or excretion determines calcium balance (Barzel US. The skeleton as an ion exchange: implications for the role of acid-base imbalance in the genesis of osteoporosis. J Bone Miner Res. 1995; 10: 1431-36).

Foods which yield a net acidic load mainly as sulfates and phosphates cause the kidneys to respond to this dietary acid challenge with net acid excretion, as well as ammonium and titratable acid excretion. Concurrently, the skeleton supplies buffer by active resorption of bone. Consequently, calciuria is directly related to net acid excretion (Barzel US, Massey LK Excess dietary protein can adversely affect bone. J Nutr 1998; 128:1051-53).

Foods which cause a net acid excretion include meat, fish, cheeses and grains (Remer T, et al. Potential renal acid loads of foods and its influence on urine pH. J Am Diet Assoc. 1995 Jul; 95: 791-97). Fruits and vegetables have a net alkaline value and consequently reduce acid excretion and hence reduce calciuria thereby halting bone resorption and actually allowing bone accretion to occur.

Although the dietary calcium to protein ration in stone age diets would have been quite low, the large amount of fruits and vegetables (35% of total energy) included in the diet would have produced a net dietary acid-base status which would have favored bone accretion even in the face of enormous protein intakes.

Similarly, nephro and urolithiasis would have been reduced from the high levels of fruit and vegetable consumption via their ability to reduce the potential renal acid load.

Robert Crayhon: ...and they thrived and were very healthy on that.

Loren Cordain: The fossil record and modern day studies of hunter gatherers suggests this. Many populations around the world consume low fat, high carbohydrate diets with little or no animal protein, yet paradoxically suffer high rates of diseases of insulin resistance and high levels of cardiovascular disease.

For example, epidemiological studies of largely vegetarian Hindu populations from the Indian sub-continent have shown mortality rates from cardiovascular disease that are similar or greater than those rates found in European countries, despite their vegetarian diet.

Robert Crayhon: And this is apparently due to the imbalance in their macronutrients?

Loren Cordain: Yes, these populations tend to have very characteristic blood lipid parameters indicative of syndrome X. They tend to have elevated triglycerides and VLDL cholesterol and reduced HDL cholesterol. Also, the oxidative profile of their lipids tends to be worse than the oxidative profile of some westerner populations because cereal grains which have no vitamin C or no pro-vitamin A beta-carotene may sometimes

displace fruits and vegetables which are a rich source of both of these antioxidants. Further, cereal grains tend to have a high Omega-6/Omega-3 ratio because they are high in linoleic acid and low in linolenic. The oxidizability of the LDL molecule increases when it's loaded up with Omega-6 fats (linoleic acid primarily).

Robert Crayhon: ...even though the Omega-3 fats are technically more delicate fats?

Loren Cordain: Recent in vivo studies suggest this may not be the case.

Robert Crayhon: This brings us to the enormous topic of the shift in the kinds of fats in the Paleolithic even through the last centuries favoring the Omega-6's...safflower, sunflower, corn oil, and arachidonic acid rich meats devoid of EPA/DHA as opposed to...

Loren Cordain: This shift has only occurred in the last 80 years or so.

Robert Crayhon: And what has happened because of that shift?

Loren Cordain: The types of fats that you eat influence the type of fats that are incorporated in the cell membrane. They can also influence hormonal profiles, and eicosanoid function. We tend to see a more inflammatory eicosanoid profile with elevated levels of Omega-6 fats.

Robert Crayhon: And also arachidonic acids?

Loren Cordain: The information is equivocal on arachidonic acid. Initial experiments indicated that arachidonic acid had mainly deleterious effects. A recent metabolic ward study of arachidonic acid indicates otherwise (Nelson GJ, et al. A human dietary arachidonic acid supplementation study conducted in a metabolic research unit: rationale and design. *Lipids*. 1997; 32: 415-420).

Arachidonic acid is an essential fatty acid in virtually every cell of the body, and it is an important precursor for prostanoid synthesis and tissue function.

More recent data suggests that the balance of arachidonic acid to long chain Omega-3 fatty acid may be more important in influencing health than absolute dietary intakes of arachidonic acid.

Robert Crayhon: How much Omega-3 to Omega-6 should we have in our diet?

Loren Cordain: In our laboratory, we have analyzed various tissues in wild game meat and we have found that muscle tissue contains Omega-6 to Omega-3 ratio of 3.5-4 to 1.

This ratio is higher in storage fat and bone marrow, and slightly lower in certain organs. In the brain, this ratio is 1 to 1. Pre-agricultural humans, as opposed to modern humans, enjoyed eating the organs of wild animals. Certainly, they were eating the brains of the animals that they killed.

The Omega-6 to Omega-3 ratio couldn't have been much lower than 4 to 1 if we only ate the meat. If we only ate the brain, it would have been roughly 1 to 1. If fish were included in the diet, it would have further reduced the 4:1 ratio found in the muscle of terrestrial animals.

Additionally, the inclusion of most plant foods (but not all) would have also reduced the 4:1 ratio. The conclusion I have come to is that:

The average Omega-6/Omega-3 ratio in pre-agricultural humans would have always been lower than 4 to 1, but probably not lower than 2 to 1 depending upon season, locale and macronutrient intake.

Robert Crayhon: Looking at the food guide pyramid now with the Paleolithic perspective that you've helped create, what would you do if you were to design an eating guide for humans as a species?

Loren Cordain: The evolutionary paradigm should be used as a starting point for designing optimal nutrition guides.

Clearly, it is not practical nor economically possible for all of the world's people to eat wild game, fruits and vegetables.

However, the macronutrient and trace nutrient levels that typically occur in reconstructed Stone Age diets should be emulated in the design of healthful diets for modern people. Humanity is totally dependent now upon cereal grains for survival.

Cereal grains provide 56% of the food energy and 50% of the protein consumed by all of the world's peoples. Without them, there would be worldwide starvation of an unprecedented proportion. We have wandered down a path of absolute dependence upon cereal grains, a path from which there is no return.

Robert Crayhon: So instead of 6-11 servings of these kinds of...well, on the pyramid I think it's not just grain products but also potatoes and other sorts of carbohydrates that are thrown in there. Would you recommend keeping 2-3 servings per day of grain products or less? Or is it really hard to make any guidelines?

Loren Cordain: I think that there is a significant amount of genetic variability among people which may influence how well they do on various types of diets. Insulin-resistant individuals do not seem to do well on high carbohydrate diets, particularly if the carbohydrate has a high glycemic index.

Generally, most people do quite well healthwise on 2-3 servings of grain products per day. Clearly, cereal grains and agriculture allowed for the dramatic worldwide human population expansion that has occurred in the past 10,000 years since the advent of agriculture.

I think what the USDA is trying to do with its Food Pyramid is to give general dietary guidelines that are beneficial for most people and which are economically feasible. I think my work is not necessarily practical for making recommendations to all of the world's people, but rather it points out how human diets may be improved from an evolutionary perspective.

Robert Crayhon: If you could speak to the modern health care practitioner, nutritionist, or physician and tell them the key things Paleolithic research has taught us, what might those be?

Loren Cordain: Animal based diets can be healthful if designed with macronutrient and trace nutrients that emulate those of our pre-agricultural ancestors. Low fat, high carbohydrate cereal and legume-based diets are not necessarily healthful.

The implications of a Paleolithic diet are that humans tend to do quite well on high protein animal-based diets in many regards including vitamin, minerals, and fatty acid profiles. The whole concept of animal-based foods as deleterious needs to be rectified. And the idea that if a little bit of whole grain is good for you, then a lot should be better, needs to be reconsidered.

Robert Crayhon: Why is it that so many people are so adamant about the negative effects of animal products? Is it because of the extraordinary difference in quality between a piece of wild game meat that may have 7-10% fat and fat of a high-quality, vs. cornfed cattle that have 40% fat of a completely different nature? Is it the pesticides or hormone residues in the meat? Is it all of the above?

Loren Cordain: Wild game muscle averages about 2% fat by weight which translates to about 15% by energy. Lean cuts of domestic meat may contain 5-7% fat by weight and 30-35% fat by energy.

Robert Crayhon: Even the well-marbled meats?

Loren Cordain: Fatty cuts of domestic meat contain about 20% fat by weight and about 63% fat by energy.

Robert Crayhon: Quite different from Paleomeat. Would a nice lean flank steak from your supermarket be 7-10% fat?

Loren Cordain: It could be slightly lower than that. There have been a couple of studies that have shown that we are looking at the 5 to 7% range in a lean cut of steak that has been cut of all visible fat, but remember this value is by weight. Fat as a percent of total calories would be approximately 30-35%. As far as growth hormones and pesticide residues, I think the evidence is equivocal and may not be as important as the differences in fat content in terms of health and nutrition. Because pesticides and heavy metals occur in areas that wild animals inhabit, they are not entirely free of these toxins either.

Robert Crayhon: What's the best way to cook meat? How and when did Paleo peoples start cooking their meat?

Loren Cordain: Organized stone hearths (and hence the first concrete evidence for the control of fire) probably did not occur until the appearance of Neanderthals roughly 200,000 years ago. So prior to this time, humans probably did not cook their meat. I do not recommend, however, eating raw or slightly cooked meat because of

potential bacterial contamination.

Robert Crayhon: What is the best way to cook meat?

Loren Cordain: The way we tend to cook meat these days is very different from the ways of hunters and gatherers who tend to slow-cook meats over a long period of time. A favored cooking procedure was digging a pit and putting in hot stones, putting in the whole animal or portions of it, putting in vegetable matter and other stones above the vegetable matter and cooking the meat all day long. So what is suggested is slow cooking at low heat.

Robert Crayhon: Throw out the microwave and get a crock pot.

Loren Cordain: Well, yes. If you take a lean cut of venison, elk, or buffalo, and throw it on the barbecue, you'll find it's as tough as rubber but if you put it on a crock pot or a Dutch oven and cook it all day long, you'll find that it will come out quite tender and also, the nutrient content remains relatively high. Also, you don't have to worry about bacterial problems.

Robert Crayhon: I know you're doing some groundbreaking work right now looking at the role of high consumption of grains as a possible trigger for many auto-immune diseases. Can you comment on that?

Loren Cordain: We don't have any clinical data at this point. We have a theoretical model which points in many directions towards exactly what you're saying.

Robert Crayhon: Are multiple sclerosis, lupus and rheumatoid arthritis rare in populations where no grain products are consumed?

Loren Cordain: Some epidemiological evidence would indicate exactly that. Part of the problem in getting epidemiological evidence like this is that there are very few populations on this planet that don't eat cereal grains...

Prior to acculturation, Eskimos and peoples of the far North were reported to have a low incidence of auto-immune diseases. With acculturation, the prevalence of auto-immune diseases are increasing in these populations and may approach Western levels.

Experimentally, we know that the expression of certain auto-immune diseases (e.g. insulin dependent diabetes mellitus IDDM) increases in animal models when they are fed high cereal grain diets.

We believe that cereal grains may influence immune function by the ability of their lectins (specifically wheat germ agglutinin-WGA) to allow passage of undegraded dietary antigens and antigens derived from intestinal pathogens (viruses and bacteria) to peripheral tissue.

Through a process called molecular mimicry, in which there are structural similarities between the body's own tissue and that of the dietary antigen and/or the intestinal pathogen antigen, the immune system loses the ability to distinguish self tissue from non-self tissue and mounts an immune attack upon the body's own tissue. Many of these structural similarities between cereal grain peptides and the body's own tissues seem to involve collagenous tissues.

Robert Crayhon: Which grains have protein sequences closest to human collagen tissue?

Loren Cordain: The literature suggests that the alcohol soluble portion of wheat contains peptide sequences that may mimic peptide sequences in the body. But it's a more complicated issue than that. It has to do with the genetics of the person with the auto-immune disease as well.

Robert Crayhon: The upshot of all this is that it couldn't hurt if you've got an auto-immune disease to try a grain-free diet.

Loren Cordain: Well, it's more than grain-free. We found again from a Paleolithic perspective that humans didn't drink a lot of dairy, nor did they consume legumes or yeast-containing foods. Dairy, legumes, and yeast contain peptides with amino acid sequence that are homologous to amino acid sequences in a variety of human tissues as well.

Robert Crayhon: What about other foods such as fowl, fish, and fruits and vegetables? Are these foods that are relatively free of these similar proteins?

Loren Cordain: Generally speaking, most people don't have trouble with land based flesh foods. Some people have trouble with shellfish or seafood from an immunological perspective. Elimination diets tend not to use shellfish or fish, as some people have trouble with these.

Robert Crayhon: But as you've said, the grains, the dietary products, the legumes, and yeast are the much more likely suspects. Any closing comments on the immune problems caused by the agricultural revolution before we close our discussion?

Loren Cordain: I think we need to have clinical trials obviously eliminating these kinds of foods: cereal grains, dairy products, legumes, and yeast. This would be difficult for people who have been weaned on a Western diet, but humans throughout most of the course of our stay on this planet did not eat those foods or rarely ate those foods.

These proteins are alien to our immune system. We would hope that clinical trials involving elimination of these suspect peptides will be done in the future and hopefully may be of benefit to people with auto-immune problems.

Robert Crayhon: Dr. Cordain, thank you for spending time with us today and sharing these groundbreaking ideas with us. Your work embodies Stravinsky's phrase that "revolution means going back all the way around to where you started from".

Loren Cordain: My pleasure, Robert.