



THE EFFECTS OF DIETARY SUPPLEMENTATION AND MEAL REPLACEMENT ON HEALTH AND WEIGHT MANAGEMENT

Jerome Stenehjem, MD
Medical Director Sharp Rehabilitation Center
San Diego, CA 92123

© GRID Clinic 2004

Summary: The principles of the GRID Diet include exercise, dietary modification, supplementation and meal replacement as methods of inhibiting glycemic response and insulin secretion and improving fat catabolism and reducing oxidative processes that accelerate aging and promote disease. Soluble dietary fiber, vegetable protein, vitamins, minerals, essential fatty acids and essential amino acids are the focus of dietary supplementation. Soluble dietary fiber and vegetable protein are the primary focus of meal replacement. A considerable body of medical literature supports these principles.

How does supplementation fit into Glycemic Response Inhibition Diet? Supplementation is really intended to do just what the name says; to *add to* something that is already there. Supplementation should not replace but should *augment* an already healthy diet. Dietary supplements include everything from vitamins and minerals, to food extracts, herbal drugs and various chemicals. Every supplement isn't necessarily healthy, just as every food isn't necessarily healthy. Ma huang, is an herb used in a number of popular weight loss supplements marketed over the last ten years. It is an ephedrine-like stimulant that has been associated with hundreds of medical complications including a number of deaths[1-3]. However, for every potentially dangerous supplement there are many more supplements that when taken properly can be healthy additions to one's diet. All dietary supplements should be carefully selected and taken in the proper amounts with the knowledge of your physician.

Recommendations for dietary supplementation should be based on scientific study not myth or anecdote (Did you hear about the brother of so-and-so?) Luckily, there is a substantial body-of-knowledge recently published in the medical literature that examines the health effects of various dietary supplements. We can use this information to help us select the dietary supplements that will help us achieve and maintain optimal health.

EVOLUTION AND ADAPTATION

Why do we need to supplement our diets at all? We need to supplement our diets because even a healthy western diet is still lacking adequate amounts of many essential nutrients needed to maintain *optimal* performance and health. Our bodies are complicated metabolic machines that require the right amount of a number of essential ingredients to run smoothly for a long time. This metabolic machine was designed over a several

million years while primitive man was evolving into modern man. Over the eons, evolution improved the survival of man by adapting his metabolism to the foods that were most available to him yet also allowing him to survive (not thrive) on a variety of foods. You may question whether the diet of primitive man, your distant ancestor, living so many years ago can be relevant to you own dietary needs today. Geneticists believe that our ancestors living 60 to 100,000 years ago were genetically identical to modern man. Even our distant cousins the chimpanzees share 95% of the same DNA (and genes) as man [4]. If primitive man was adapted to the foods that were available to him, and if we share identical genetic makeup with primitive man, then, the healthiest diet for us should be very similar to the diet of our primitive ancestors living several hundred thousand years. Although the evidence for this concept is limited, it is nevertheless somewhat compelling.

FINDING THE DIET THAT WE WERE DESIGNED TO EAT

Attempting to determine the actual diet of primitive man has been a challenge steeped in considerable controversy. Some of the clues come from the teeth and jaw structure of early man. The anatomy of early man suggests that he was a grinder of plant foods rather than primarily a meat eater[5-8]. Studies of food acidity, tooth scrapings, and metabolism also point to a largely plant based diet of early man[9]. Tools recovered from some of the archeological sites of primitive man are long, thin and very smooth remnants of bone and horn. Anthropologists have determined that these specialized tools were used by *Australopithecus robustus* a distant cousin of the earliest man to dig for termites[10]. Termites and probably other insects were a significant source of dietary protein for primitive man. Primitive man probably ate meat



Digging tools of the *Australopithecus robustus*

when available and may have lived exclusively on animal flesh during some periods. However, many anthropologists doubt that primitive man invested the time nor exposure to danger

required in order for him to hunt large animals. Evidence from animal kills suggests that early man was more likely a scavenger of meat left behind. The preponderance of evidence though less exciting than the loincloth covered hunter suggests that the evolutionary pressure over several hundred thousand years was to conform to a primarily plant-based diet with limited protein. Unfortunately, for modern man, a diet that simulates the diet of primitive man is impractical and for most, unpalatable. However, a healthy compromise can be found by simply increasing vegetable and whole grain carbohydrates and reducing or eliminating highly processed carbohydrates in our diets. (You can learn more about dietary modification in the GRID Diet section.) The second way to shift our diet to more closely approximate primitive man is to supplement the diet with the healthiest substances that are found in unprocessed plant foods such as dietary fiber, vegetable protein and vitamins and minerals.

MAKING HEALTHY SUPPLEMENTS FROM HEALTHY FOODS

Supplements can help close the gap between the less-than-perfect diet that we are likely to maintain and the perfect diet that we want to attain. There are hundreds if not thousands of supplements on the market. How do we know which ones will improve our nutrition and make our total diet as healthy as possible? We ask a simple question: “What does the medical literature show?” Luckily, thousands of studies on the various aspects and elements of nutrition have been performed over the last 20 years. As our knowledge-base has broadened we have been



Jaw of Peking Man living 500,000 to 300,000 years ago

able to identify many foods that are associated with good health and long life and also some foods that are associated with poor health. Not only have healthy foods been identified but, other studies have delved into what aspect or nutrient of a healthy food makes it healthy. The next logical step is to determine if supplementing our diets with these nutrients can improve our health. Let's find out more about these healthy foods, healthy food extracts and nutrients.

HEALTH AND DIETARY FIBER

A careful study of the health and dietary habits of over 60,000 nurses living in the Boston area was conducted over a 10 year period[11]. In this study, the nurses were divided into four groups based on how much fiber they consumed each day. The nurses with the highest fiber intake had about ½ the incidence of cardiac disease as those with the lowest fiber intake. In another study, the dietary habits of 36,000 women living in Iowa were studied to determine if whole grain and dietary fiber consumption reduced their risk of diabetes [12]. Those women with the highest consumption of whole grain and dietary fiber had a 20% reduction in their risk of having diabetes mellitus compared with those consuming the least amount of whole grain and dietary fiber. Diets high in fiber also appear to help in controlling diabetes and to promote weight loss in obese children [13]. In a study of 2909 young adult males, higher dietary fiber intake was associated with lower body weight, lower blood pressure, lower fasting insulin levels, lower peak post-prandial blood glucose levels, lower low-density cholesterol and higher high-density cholesterol levels [14]. That's like hitting two grand slam home runs in the same baseball game!

In an Italian study, over 900 cancer patients were compared with 1950 matched controls. The incidence of oral, pharyngeal, and esophageal cancers were examined by dividing the subjects into 4 groups based on their dietary fiber intake. Those with the lowest intake of dietary fiber were 2 ½ times more likely to develop these cancers than

individuals with the highest dietary fiber intake[15]. Based on these and many other studies, foods that are high in fiber appear to have significant health benefits that include reducing the risk of certain cancers, reducing risk of cardiac disease, reducing risk of diabetes and improving weight management.

SOLUBLE VS INSOLUBLE DIETARY FIBER

Given all this information on dietary fiber, it would make sense to not only increase the amount of high fiber food in our diets, but to also *supplement* our diets with fiber. Which types of dietary fiber are going to be the very best? Let's turn again to the scientific studies in this area. Dietary fiber is a non-digestible carbohydrate that can be divided into two types, insoluble or soluble. Cellulose or paper pulp is the most common form of insoluble dietary fiber and there's lots of it in fruits and vegetables. Insoluble dietary fiber provides bulk or roughage and is effective in keeping the digestive system regular. The second category of dietary fiber is the *soluble* dietary fibers present in fruits, legumes, the husks of whole grains and seeds, and in the gums from several trees and plants. Whereas, the health benefits of *insoluble* dietary fiber appear to be limited, the health benefit of *soluble* dietary fiber appears to be almost unlimited. One review article looking at the effects of soluble fiber supplementation on serum cholesterol found that 68 of the 77 (88%) human studies performed showed a significant reduction in the level of serum total cholesterol by soluble fiber[16]. Improvements in diabetic control have been shown when diabetics supplement their diets with foods high in the soluble fibers, beta glucan and psyllium[17-19]. A number of other studies have also shown significant improvements in blood cholesterol levels when supplementing with psyllium[19-22]. Similar beneficial effects on blood cholesterol levels have been observed when the soluble fibers, acacia gum and pectin are used as supplements[23, 24]. *Processed* cereals are known to significantly elevate post prandial (after eating) blood glucose levels, however cereals high

in the soluble fiber beta glucan, demonstrate significantly lower postprandial blood glucose levels[17]. The Nurse's Health Study conducted on 60,000 nurses also showed significant cardiac benefits from diets high in cereal grains containing *soluble* fiber but insignificant health benefits from fruits and vegetables high in *insoluble* fiber [11]. Based on the current medical literature, *soluble* dietary fiber appears to be an excellent ingredient to include in our list of healthy dietary supplements.

HOW SOLUBLE DIETARY FIBER PROMOTES HEALTH

There are quite a few soluble dietary fibers, each with its own history and science surrounding it. However, all of the soluble dietary fibers appear to have similar effects in that they increase the viscosity of the meal thus slowing gastric emptying and delaying absorption[17]. Slowing gastric emptying is an obvious mechanism for lowering glycemic response. Soluble dietary fibers also tend to bind foods in the gut thus delaying mixing and contact with the bowel wall thus further delaying absorption of calories. Soluble fiber essentially causes the food that you have eaten to be stored longer in the gut. This results in the calories being absorbed more slowly so that they become available as you need them, rather than being quickly absorbed and converted into fat. Soluble dietary also provides bulk that results in a sensation of fullness that helps control hunger. Soluble dietary fiber has also been shown to lower serum cholesterol (perhaps by binding bile in the gut) and to raise high density lipoprotein (the good cholesterol)[25-27]. So, which soluble dietary fibers have the best medical evidence? Soluble dietary fibers that have substantial scientific evidence for promoting better health through weight reduction, improved cholesterol levels and improved glycemic response include: psyllium husk, acacia gum, beta glucan, pectin, and guar gum[16, 23, 27-30]. Dietary fiber should always be taken with adequate water or other fluid. When not taken with adequate water it can cause blockage of the gastrointestinal tract.

PROTEIN

There's more than just soluble dietary fiber on the health radar screen. Vegetable proteins (like soy) are also showing significant health benefits. We don't typically think of protein, (one of the three primary food types) as a supplement. However, body builders and other high performance athletes have learned that they can increase their lean body mass by supplementing their diets with protein[31]. Whey protein from milk and protein extracted from eggs are two commonly used sources of animal protein. Animal protein supplementation however has some undesirable effects. The most important of these is that animal protein increases insulin secretion when consumed with carbohydrates[32]. Vegetable proteins on the other hand increase the secretion of glucagon which balance the effect of insulin[33]. Controlling insulin secretion is central to the principles of GRID so that makes animal protein a poor choice for supplementation. Vegetable protein supplementation however, has other important health benefits including improved weight loss for obese subjects[34-36]. Soy protein, one of the most ubiquitous vegetable protein isolates has been shown to reduce risk factors for cancer, obesity and cardiac disease[33]. When soy protein and guar gum are given together as a supplement they have been shown to lower low-density lipoprotein without lowering high-density lipoprotein levels[37].

Soluble dietary fiber and vegetable protein both have excellent and well documented health benefits. Combining both these ingredients into a single dietary supplement creates an even greater effect than when either of these nutrients is used alone. Because soluble dietary fiber alone provides no usable calories, combining soluble fiber with vegetable protein can provide needed dietary fiber and calories without any appreciable effect of increasing blood glucose or insulin levels. When properly blended, soluble fiber and vegetable protein can serve as a supercharged mini-meal, a between-meal snack or as a pre-meal supplement to slow absorption and extend the

satiating effect of a meal. This helps to reduce between-meal snacking.

VITAMINS AND MINERALS

– Essential or Over-rated?

Vitamins (also called coenzymes) act as catalysts for many important metabolic reactions. Although our bodies can make protein, carbohydrates and fats, we are unable to make vitamins. This is why vitamins are truly an *essential* nutrient. Thanks to improved diets, diseases like scurvy, pellagra, and pernicious anemia are almost unheard of in developed countries. The fortification of bread and other products with folic acid has also reduced the incidence of birth defects like spina bifida. But, if you are on a healthy diet and you aren't ill or pregnant, is it necessary to supplement with vitamins? That's been a subject of considerable controversy for a number of years. A search of "vitamins" on the United States Department of Agriculture (USDA) website reveals a short article from the U. S. Agriculture Research Service that states: "Required amounts of most nutrients can be met by diet alone." This statement is derived from the concept that a well-rounded diet based on the USDA Food Guide Pyramid *should* provide adequate amounts of essential nutrients. As is frequently the case, the devil *is* in the details. This is because the operative term "required amounts" does not specify the outcome. Is it the required amount of a nutrient in order to prevent disease or is it the required amount of a nutrient to provide optimal vigor, optimal health or greatest longevity? While a "diet alone" approach will prevent most diseases there is considerable evidence that now indicates that diet alone does not provide enough vitamins and other essential nutrients for optimal health and wellbeing. Furthermore a number of conditions that are precursors to serious illness or death may be corrected with vitamin or mineral supplementation. Only with recent extensive epidemiological and clinical studies has it been possible to determine the subtle but important health benefits derived from vitamins and minerals. A few examples may illustrate this point.

Folic acid is one of the unnumbered "B" vitamins that has been shown to work together with vitamin B-6 and vitamin B-12 to reduce levels of homocysteine. Homocysteine is an amino acid that when elevated is associated with an increased risk of heart attack and stroke and with a loss of circulation in the hands and feet[38]. In the Nurses Health Study, women with the highest intake of vitamin B6 and folic acid were half as likely to have heart attacks compared to women with the lowest levels of vitamin B6 and folate in their diet[39]. Those nurses who *supplemented* their diets with vitamins were found to have the *lowest* incidence of heart disease. The authors of this study concluded: "These results suggest that intake of folate (folic acid) and vitamin B6 above the current recommended dietary allowance may be important in the primary prevention of CHD [11] among women". Folic acid is present in fruits and vegetables. Spinach is rich in folic acid with about 130 mcg found in one bowl. Two slices of *enriched* bread contain about 40mcg of folic acid [24]. The Recommended Daily Allowance (RDA) of folic acid is 400mcg per day, the amount present in three bowls of spinach or 20 slices of bread. Clearly even the best diet will fall short of meeting the RDA of 400mcg per day of folic acid. If you are interested in reducing your risk of heart attack and stroke, supplementing your diet with folic acid makes sense.

Niacin, (also known as Vitamin B3) has been shown to help lower cholesterol levels. It also helps oxidize fats, carbohydrates and amino acids for energy production. Deficiencies in niacin cause the tongue to become swollen and painful and eventually leads pellagra. Pellagra was common 100 years ago and would manifest as a painful raw rash over the face, hands and feet. Dementia and diarrhea were other common symptoms associated with pellagra. The RDA of Niacin is 18 milligrams for men and 13 milligrams for women. Although deficiencies in niacin lead to pellagra, what happens when niacin intake is greater than that needed to prevent disease? Higher intake of niacin has been found to be very effective in helping to control blood

lipids (cholesterol and triglycerides) [40]. You may have seen niacin in your pharmacy or health food store in 50, 100 or 200mg tablets and experienced the temporary rash and flushing of the face and trunk that may occur after taking this vitamin. Physicians are now prescribing niacin in amounts of 1000 to 2000 milligrams a day (in slow release formulas) to treat high cholesterol levels. This is about 100 times more than the RDA. Would you settle for 13mg or 18mg a day for optimal health? For most individuals supplementing their diet with niacin 100mg several times a day is a good idea. If you have elevated cholesterol or triglycerides, then ask your physician about taking larger amounts of niacin.

Vitamin E is another interesting subject. Vitamin E is an antioxidant. Antioxidants are a class of nutrients that helps prevent degenerative changes that occur when oxygen (or other “oxidizing” chemicals) combine with other molecules in the body. This process can occur in vessel walls, in nerves and other important structures in the body. When iron oxidizes we call it ‘rust’. Without the benefit of antioxidants, one can imagine our blood vessels and other tissues ‘rusting’ over time. Many studies have looked at the beneficial effects of vitamin E on reducing heart disease and other problems that occur when healthy tissues oxidize to make them unhealthy [41, 42]. The RDA for vitamin E is 30 international units (IU). The USDA estimates the average daily dietary intake of vitamin E at about 17 IU per day. How much vitamin E does it take to have an antioxidant effect? It takes 400 to 800 IU or about 15 to 25 times more than the established RDA and 30 to 60 times more than the typical diet provides! If you still feel that you want to get your vitamin E through diet alone, consider that it will take about a pound of nuts to get 400 IU of vitamin E. Supplementing with Vitamin E 400 to 800 IU makes sense.

Minerals (elements) are also essential to our bodies. There are the macrominerals; sodium, chloride, potassium, calcium, phosphorus and magnesium that are required in quantities greater than 1 gram a day and the essential trace minerals including iron,

iodine, fluorine, zinc, chromium, selenium, manganese, molybdenum and copper. An explanation of the role of all of the minerals is beyond the scope of this paper, however, several of the minerals have important roles in blood glucose control, cholesterol and weight management.

Calcium is a mineral that has long been promoted for maintaining healthy bones (especially in women). However, calcium has also been found to play an important role in preventing hypertension and obesity[43, 44]. This unexpected role of calcium is mediated through vitamin D. When dietary calcium is inadequate vitamin D is activated in such a way that more calcium enters the fat cells triggering increased fat storage. Increasing dietary calcium leads to increased lipolysis (fat burning) increased thermogenesis (metabolic rate) and weight loss[44]. The RDA of calcium is 800 to 1200mg a day. It takes about a quart of milk to supply this much calcium. Certain vegetables like broccoli are high in calcium but it takes about 4.5 lbs of broccoli to provide your RDA. Although dairy products have been shunned by most diets, recent studies have shown that calcium obtained from dairy products is associated with greater weight loss than calcium taken as a supplement [45]. However, this successful use of dairy products with dieting occurred with caloric reduction not unlimited intake of dairy products. What’s the bottom line regarding calcium, dairy products and dieting? With appropriate caloric restriction (1500Kcal per day) one may consume up to two glasses of milk or ½ cup of ice cream a day. Calcium (1 gram) should also be taken as a supplement in the morning and 1 gram at night.

Magnesium is a macronutrient that is essential for normal cell metabolism. There is a strong association between lower magnesium intake and magnesium blood levels and diabetes mellitus[46, 47]. Though magnesium replacement has not been effective in treating Type 2 diabetes[48], it can improve cholesterol profiles[49]. Obese individuals have also been found to have reduced magnesium levels in their platelets and red blood

cells[50, 51]. Obese individuals with lower levels of magnesium in their blood cells are also much more likely to exhibit cardiac arrhythmias[52]. Although the causal relationships are not well defined, the association of reduced magnesium intake and blood levels with diabetes mellitus and obesity suggest that supplementation with magnesium is advisable for individuals seeking to control their weight or those at risk for or suffering from diabetes.

Selenium is another antioxidant micronutrient that tends to “fly under the radar” much of the time. Selenium, however does have important implications in diabetes and secondarily weight management. In one study, diabetics were found to have statistically lower selenium levels in their blood than matched controls[53]. In another study women who developed diabetes during pregnancy were found to have significantly lower selenium levels. In animal studies selenium has been shown to protect the heart muscle from commonly seen diabetic complications[54, 55]. The RDA of selenium is 75mcg. Selenium however can be toxic. Although the British have estimated a safe upper limit of 450mcg per day the National Academy of Sciences has recommended 50 to 200mcg per day as a safe range of selenium intake. There is an estimated 90 to 340 micrograms of selenium in an 8 Oz serving of seafood[56]. Although supplementation with selenium may help prevent diabetes and its complications, it would appear unnecessary and imprudent to supplement one’s diet with more than 200 mcg of selenium per day.

Chromium, an essential micronutrient, is yet another case of the “RDA” problem. The RDA of chromium is 120mcg yet most experts agree that the typical American diet will not provide this much chromium [57]. Chromium supplementation has been shown to improve levels of high density lipoprotein (HDL) in the blood (that’s good!)[58]. Other studies have shown reductions in triglyceride levels with chromium supplementation [59]. Other studies have shown lowering of elevated insulin levels in individuals who received chromium supplementation when compared with individuals given placebo[57]. However, these scientific

studies showed benefit when supplementing with 200 to 250mcg of chromium a day (over and above what is found in the diet). Yet the RDA for chromium is set at 120mcg, significantly more than what the average diet in the US will provide and only one half the amount that has been shown to provide significant health benefits. If you want to reap the health benefits of chromium seen in numerous scientific studies you will probably need to supplement your diet with this mineral.

Alpha lipoic acid is another powerful antioxidant with pervasive influence on various metabolic functions. One of its key effects is to block oxidative stress that occurs with aging and in diabetes. Many studies have shown that alpha lipoic acid can improve circulation and nerve function in diabetes [60, 61]. Alpha lipoic acid also works within the mitochondria, the energy producing unit within the cells to improve utilization of glucose[61, 62]. It helps with dilation of vessels that would otherwise be choked off from the cumulative effects of elevated blood glucose levels. Significant memory improvements have been substantiated in aging rats given alpha lipoic acid [61, 62]. Improvements in blood pressure, blood glucose and insulin levels have also been reported in animal studies following the administration of alpha lipoic acid [63]. Alpha lipoic acid is difficult to obtain in significant amounts from diet alone. It is available in 100 and 200mg tablets that may be taken 2 to 3 times daily.

L-carnitine is an amino acid (protein building block) that is present in energy demanding tissues such as skeletal and cardiac muscles the liver and adrenal glands. It is essential for the metabolism of long-chain fatty acids in the mitochondria[64]. Although it has long been promoted for losing fat and building muscle, its effectiveness for this is not substantiated. In at least one recent study it was ineffective in helping middle aged obese women lose weight while in an aerobic exercise program[65]. Nevertheless, L-carnitine has been shown to reduce cholesterol levels [66, 67], improve insulin sensitivity in normals and to improve beta cell (diabetic) function in dialysis patients [68-70]. Lastly, in several studies of

infertile men, L-carnitine levels in the seminal fluid were found to be low. Supplementation with 2 grams per day of L-carnitine resulted in significant improvement in semen quality [71, 72]. Although the effectiveness of L-carnitine in weight loss or diabetes management is unproven, it does appear to be safe and without significant side effects.

Essential fatty acids (EFAs) are our last topic. With the broad assault waged against dietary fat in the last 20 years, one might be surprised to learn that some forms of fat are absolutely essential to our health. You have likely heard of these important nutrients as the omega 3 and omega 6 EFAs. The omega 3 EFAs are linolenic acid, eicosapentaenoic acid and docosahexaenoic acid. The omega 6 EFAs are linoleic (not linolenic) acid and arachidonic acid. Why are these fatty acids essential? As with other essential nutrients we must have them for proper metabolism and repair processes and our bodies cannot make them. We use EFAs to make hormone-like chemicals that are important in cellular repair, controlling inflammation, controlling blood clotting and in balancing our levels of circulating lipoproteins and triglycerides. The EFA's in our diet come primarily from vegetable and fish oils. Hence the recent popularity in salmon as it is the high in both omega 3 and omega 6 EFAs. The polyunsaturated vegetable oils are also high in EFAs, primarily omega 6. When cholesterol was first identified as a chemical in the bloodstream that would lead to heart disease, it was assumed that eliminating all fat from the diet would reduce cholesterol levels. However, inadequate EFA's actually increased cholesterol levels while increased EFA's in the diet lowers low-density lipoprotein (the bad cholesterol) and increase high-density lipoprotein (the good cholesterol). Fish oil supplementation in diabetics has demonstrated some improvement in nerve function in diabetic rats [73] and lowering of triglycerides in humans thought it may increase low-density lipoprotein in higher doses[74, 75]. EFA's are also important in fat metabolism[76]. An important caveat to EFA's is arachidonic acid (which is found in organ meats and egg yolks). This EFA is associated with increased risk of cancer and heart disease[77, 78]. An important finding regarding the ratio of omega 3

and omega 6 EFAs in the diet resulted from studies on the Inuit Indians. Their diet is equally balance in omega 3 and omega 6 EFAs. The typical western diet has a ratio of 50:1 for omega 6 to omega 3 EFAs. Westerners also have 7 times the death rate from cardiovascular disease as Inuit Indians. This has resulted in the recommendation that supplementation with omega 6 is likely not needed. Supplementation with omega 3 can help bring these two essential nutrients into better balance.

SUMMARY

The GRID Diet Program recommends supplementation with soluble fiber, vegetable protein, vitamins and minerals, and essential amino acids and fatty acids for several reasons. First, proper supplementation can replace unhealthy calories with healthy, low-glycemic-load calories. Second, supplementation can lower the glycemic response of foods eaten that are eaten in close proximity. Third, low calorie supplementation can provide a sense of fullness or satiety that reduces the desire to eat. Lastly, soluble fiber, vegetable protein, vitamins and minerals, and other essential nutrients can actually improve your bodies metabolic responses to reduce fat storage and increase fat catabolism while reducing the risk of diabetes, heart disease and stroke. The antioxidants found in many of these supplements can also reduce the effects of aging and the complications of diabetes.

On a note of caution, the fat-soluble vitamins A, D and E and also selenium can be dangerous if taken in excess. Always take a measured and sensible approach to the use of vitamins, minerals and other nutrient supplements. Remember that it is always advisable to consult your doctor prior to taking supplements in order to avoid interactions with your medications or other unwanted effects.

References:

1. Bent, S., et al., *The relative safety of ephedra compared with other herbal products*. Ann Intern Med, 2003. **138**(6): p. 468-71.
2. Glazer, G., *Long-term pharmacotherapy of obesity 2000: a review of efficacy and safety*. Arch Intern Med, 2001. **161**(15): p. 1814-24.
3. Haller, C.A. and N.L. Benowitz, *Adverse cardiovascular and central nervous system events associated with dietary supplements containing ephedra alkaloids*. N Engl J Med, 2000. **343**(25): p. 1833-8.
4. Britten, R.J., *Divergence between samples of chimpanzee and human DNA sequences is 5%, counting indels*. Proc Natl Acad Sci U S A, 2002. **99**(21): p. 13633-5.
5. White, T.D., et al., *Jaws and teeth of Australopithecus afarensis from Maka, Middle Awash, Ethiopia*. Am J Phys Anthropol, 2000. **111**(1): p. 45-68.
6. Cooperman, H.N., *Organic tooth wear--overlooked in anatomy texts*. Med Hypotheses, 1992. **38**(2): p. 102-5.
7. Eaton, S.B., *What did our late paleolithic (preagricultural) ancestors eat?* Nutr Rev, 1990. **48**(5): p. 227-30.
8. Garn, S.M. and W.R. Leonard, *What did our ancestors eat?* Nutr Rev, 1989. **47**(11): p. 337-45.
9. Frassetto, L., et al., *Diet, evolution and aging--the pathophysiologic effects of the post-agricultural inversion of the potassium-to-sodium and base-to-chloride ratios in the human diet*. Eur J Nutr, 2001. **40**(5): p. 200-13.
10. Backwell, L.R. and F. d'Errico, *Evidence of termite foraging by Swartkrans early hominids*. Proc Natl Acad Sci U S A, 2001. **98**(4): p. 1358-63.
11. Wolk, A., et al., *Long-term intake of dietary fiber and decreased risk of coronary heart disease among women*. Jama, 1999. **281**(21): p. 1998-2004.
12. Meyer, K.A., et al., *Carbohydrates, dietary fiber, and incident type 2 diabetes in older women*. Am J Clin Nutr, 2000. **71**(4): p. 921-30.
13. Pereira, M.A. and D.S. Ludwig, *Dietary fiber and body-weight regulation. Observations and mechanisms*. Pediatr Clin North Am, 2001. **48**(4): p. 969-80.
14. Ludwig, D.S., et al., *Dietary fiber, weight gain, and cardiovascular disease risk factors in young adults*. Jama, 1999. **282**(16): p. 1539-46.
15. Soler, M., et al., *Fiber intake and the risk of oral, pharyngeal and esophageal cancer*. Int J Cancer, 2001. **91**(3): p. 283-7.
16. Glore, S.R., et al., *Soluble fiber and serum lipids: a literature review*. J Am Diet Assoc, 1994. **94**(4): p. 425-36.
17. Wursch, P. and F.X. Pi-Sunyer, *The role of viscous soluble fiber in the metabolic control of diabetes. A review with special emphasis on cereals rich in beta-glucan*. Diabetes Care, 1997. **20**(11): p. 1774-80.
18. Lafrance, L., et al., *Effects of different glycaemic index foods and dietary fibre intake on glycaemic control in type 1 diabetic patients on intensive insulin therapy*. Diabet Med, 1998. **15**(11): p. 972-8.
19. Anderson, J.W., et al., *Effects of psyllium on glucose and serum lipid responses in men with type 2 diabetes and hypercholesterolemia*. Am J Clin Nutr, 1999. **70**(4): p. 466-73.
20. Davidson, M.H., et al., *A psyllium-enriched cereal for the treatment of hypercholesterolemia in children: a controlled, double-blind, crossover study*. Am J Clin Nutr, 1996. **63**(1): p. 96-102.
21. Davidson, M.H., et al., *Long-term effects of consuming foods containing psyllium seed husk on serum lipids in subjects with hypercholesterolemia*. Am J Clin Nutr, 1998. **67**(3): p. 367-76.
22. Anderson, J.W., et al., *Cholesterol-lowering effects of psyllium intake adjunctive to diet therapy in men and women with hypercholesterolemia: meta-*

- analysis of 8 controlled trials. *Am J Clin Nutr*, 2000. **71**(2): p. 472-9.
23. Jensen, C.D., et al., *The effect of acacia gum and a water-soluble dietary fiber mixture on blood lipids in humans*. *J Am Coll Nutr*, 1993. **12**(2): p. 147-54.
 24. Mee, K.A. and D.L. Gee, *Apple fiber and gum arabic lowers total and low-density lipoprotein cholesterol levels in men with mild hypercholesterolemia*. *J Am Diet Assoc*, 1997. **97**(4): p. 422-4.
 25. Jenkins, D.J., et al., *Effect of a very-high-fiber vegetable, fruit, and nut diet on serum lipids and colonic function*. *Metabolism*, 2001. **50**(4): p. 494-503.
 26. Buhman, K.K., et al., *Dietary psyllium increases expression of ileal apical sodium-dependent bile acid transporter mRNA coordinately with dose-responsive changes in bile acid metabolism in rats*. *J Nutr*, 2000. **130**(9): p. 2137-42.
 27. Choi, Y.S., et al., *Effects of soluble dietary fibers on lipid metabolism and activities of intestinal disaccharidases in rats*. *J Nutr Sci Vitaminol (Tokyo)*, 1998. **44**(5): p. 591-600.
 28. Sierra, M., et al., *Effects of ispaghula husk and guar gum on postprandial glucose and insulin concentrations in healthy subjects*. *Eur J Clin Nutr*, 2001. **55**(4): p. 235-43.
 29. Haskell, W.L., et al., *Role of water-soluble dietary fiber in the management of elevated plasma cholesterol in healthy subjects*. *Am J Cardiol*, 1992. **69**(5): p. 433-9.
 30. Yamada, K., et al., *Dietary effect of guar gum and its partially hydrolyzed product on the lipid metabolism and immune function of Sprague-Dawley rats*. *Biosci Biotechnol Biochem*, 1999. **63**(12): p. 2163-7.
 31. Burke, D.G., et al., *The effect of whey protein supplementation with and without creatine monohydrate combined with resistance training on lean tissue mass and muscle strength*. *Int J Sport Nutr Exerc Metab*, 2001. **11**(3): p. 349-64.
 32. McCarty, M.F., *The origins of western obesity: a role for animal protein?* *Med Hypotheses*, 2000. **54**(3): p. 488-94.
 33. McCarty, M.F., *Vegan proteins may reduce risk of cancer, obesity, and cardiovascular disease by promoting increased glucagon activity*. *Med Hypotheses*, 1999. **53**(6): p. 459-85.
 34. Hermansen, K., et al., *Beneficial effects of a soy-based dietary supplement on lipid levels and cardiovascular risk markers in type 2 diabetic subjects*. *Diabetes Care*, 2001. **24**(2): p. 228-33.
 35. Hermansen, K., et al., *Effects of soy and other natural products on LDL:HDL ratio and other lipid parameters: a literature review*. *Adv Ther*, 2003. **20**(1): p. 50-78.
 36. Lee, M. and I. Kim, *Soy protein and obesity*. *Nutrition*, 2000. **16**(6): p. 459-60.
 37. Wilson, T.A., S.R. Behr, and R.J. Nicolosi, *Addition of guar gum and soy protein increases the efficacy of the American Heart Association (AHA) step I cholesterol-lowering diet without reducing high density lipoprotein cholesterol levels in non-human primates*. *J Nutr*, 1998. **128**(9): p. 1429-33.
 38. Willett, W., et al., *Eat, drink, and be healthy :b the Harvard Medical School guide to healthy eating*. 2001, New York: Simon & Schuster Source. 299.
 39. Rimm, E.B., et al., *Folate and vitamin B6 from diet and supplements in relation to risk of coronary heart disease among women*. *Jama*, 1998. **279**(5): p. 359-64.
 40. Grundy, S.M., et al., *Efficacy, safety, and tolerability of once-daily niacin for the treatment of dyslipidemia associated with type 2 diabetes: results of the assessment of diabetes control and evaluation of the efficacy of niaspan trial*. *Arch Intern Med*, 2002. **162**(14): p. 1568-76.
 41. Rodriguez-Porcel, M., et al., *Long-term antioxidant intervention improves myocardial microvascular function in experimental hypertension*. *Hypertension*, 2004. **43**(2): p. 493-8.
 42. Dhein, S., et al., *Effect of chronic treatment with vitamin E on endothelial dysfunction in a type I in vivo diabetes*

- mellitus model and in vitro*. J Pharmacol Exp Ther, 2003. **305**(1): p. 114-22.
43. Zemel, M.B., *Calcium modulation of hypertension and obesity: mechanisms and implications*. J Am Coll Nutr, 2001. **20**(5 Suppl): p. 428S-435S; discussion 440S-442S.
 44. Zemel, M.B., *Regulation of adiposity and obesity risk by dietary calcium: mechanisms and implications*. J Am Coll Nutr, 2002. **21**(2): p. 146S-151S.
 45. Zemel, M.B., *Role of calcium and dairy products in energy partitioning and weight management*. Am J Clin Nutr, 2004. **79**(5): p. 907S-12S.
 46. Song, Y., et al., *Dietary magnesium intake in relation to plasma insulin levels and risk of type 2 diabetes in women*. Diabetes Care, 2004. **27**(1): p. 59-65.
 47. Walti, M.K., et al., *Low plasma magnesium in type 2 diabetes*. Swiss Med Wkly, 2003. **133**(19-20): p. 289-92.
 48. Barbagallo, M., et al., *Role of magnesium in insulin action, diabetes and cardio-metabolic syndrome X*. Mol Aspects Med, 2003. **24**(1-3): p. 39-52.
 49. Lal, J., et al., *Effect of oral magnesium supplementation on the lipid profile and blood glucose of patients with type 2 diabetes mellitus*. J Assoc Physicians India, 2003. **51**: p. 37-42.
 50. Zemva, A. and Z. Zemva, *Ventricular ectopic activity, left ventricular mass, hyperinsulinemia, and intracellular magnesium in normotensive patients with obesity*. Angiology, 2000. **51**(2): p. 101-6.
 51. De Leeuw, I., G. Vansant, and L. Van Gaal, *Magnesium and obesity: influence of gender, glucose tolerance, and body fat distribution on circulating magnesium concentrations*. Magnes Res, 1992. **5**(3): p. 183-7.
 52. Takaya, J., et al., *Intracellular magnesium of platelets in children with diabetes and obesity*. Metabolism, 2003. **52**(4): p. 468-71.
 53. Navarro-Alarcon, M., et al., *Serum and urine selenium concentrations as indicators of body status in patients with diabetes mellitus*. Sci Total Environ, 1999. **228**(1): p. 79-85.
 54. Ayaz, M., et al., *Protective effect of selenium treatment on diabetes-induced myocardial structural alterations*. Biol Trace Elem Res, 2002. **89**(3): p. 215-26.
 55. Kowluru, R.A., R.L. Engerman, and T.S. Kern, *Diabetes-induced metabolic abnormalities in myocardium: effect of antioxidant therapy*. Free Radic Res, 2000. **32**(1): p. 67-74.
 56. Ziegler, E.E., L.J. Filer, and International Life Sciences Institute-Nutrition Foundation., *Present knowledge in nutrition*. 7th ed. 1996, Washington, D.C.: ILSI Press International Life Sciences Institute. xiv, 684.
 57. Wilson, B.E. and A. Gondy, *Effects of chromium supplementation on fasting insulin levels and lipid parameters in healthy, non-obese young subjects*. Diabetes Res Clin Pract, 1995. **28**(3): p. 179-84.
 58. Abraham, A.S., B.A. Brooks, and U. Eylath, *The effects of chromium supplementation on serum glucose and lipids in patients with and without non-insulin-dependent diabetes*. Metabolism, 1992. **41**(7): p. 768-71.
 59. Lee, N.A. and C.A. Reasner, *Beneficial effect of chromium supplementation on serum triglyceride levels in NIDDM*. Diabetes Care, 1994. **17**(12): p. 1449-52.
 60. El Midaoui, A. and J. de Champlain, *Prevention of hypertension, insulin resistance, and oxidative stress by alpha-lipoic acid*. Hypertension, 2002. **39**(2): p. 303-7.
 61. Shotton, H.R., S. Broadbent, and J. Lincoln, *Prevention and partial reversal of diabetes-induced changes in enteric nerves of the rat ileum by combined treatment with alpha-lipoic acid and evening primrose oil*. Auton Neurosci, 2004. **111**(1): p. 57-65.
 62. Liu, J., et al., *Memory loss in old rats is associated with brain mitochondrial decay and RNA/DNA oxidation: partial reversal*

- by feeding acetyl-L-carnitine and/or R-alpha-lipoic acid. Proc Natl Acad Sci U S A, 2002. **99**(4): p. 2356-61.
63. Vasdev, S., et al., *Dietary alpha-lipoic acid supplementation lowers blood pressure in spontaneously hypertensive rats.* J Hypertens, 2000. **18**(5): p. 567-73.
 64. Evangeliou, A. and D. Vlassopoulos, *Carnitine metabolism and deficit--when supplementation is necessary?* Curr Pharm Biotechnol, 2003. **4**(3): p. 211-9.
 65. Villani, R.G., et al., *L-Carnitine supplementation combined with aerobic training does not promote weight loss in moderately obese women.* Int J Sport Nutr Exerc Metab, 2000. **10**(2): p. 199-207.
 66. Sirtori, C.R., et al., *L-carnitine reduces plasma lipoprotein(a) levels in patients with hyper Lp(a).* Nutr Metab Cardiovasc Dis, 2000. **10**(5): p. 247-51.
 67. Derosa, G., et al., *The effect of L-carnitine on plasma lipoprotein(a) levels in hypercholesterolemic patients with type 2 diabetes mellitus.* Clin Ther, 2003. **25**(5): p. 1429-39.
 68. Vazellov, E., et al., *L-carnitine consecutively administered to patients on hemodialysis improves beta-cell response.* Int J Artif Organs, 2003. **26**(4): p. 304-7.
 69. Giancaterini, A., et al., *Acetyl-L-carnitine infusion increases glucose disposal in type 2 diabetic patients.* Metabolism, 2000. **49**(6): p. 704-8.
 70. De Gaetano, A., et al., *Carnitine increases glucose disposal in humans.* J Am Coll Nutr, 1999. **18**(4): p. 289-95.
 71. Lenzi, A., et al., *Use of carnitine therapy in selected cases of male factor infertility: a double-blind crossover trial.* Fertil Steril, 2003. **79**(2): p. 292-300.
 72. Matalliotakis, I., et al., *L-carnitine levels in the seminal plasma of fertile and infertile men: correlation with sperm quality.* Int J Fertil Womens Med, 2000. **45**(3): p. 236-40.
 73. Gerbi, A., et al., *Fish oil supplementation prevents diabetes-induced nerve conduction velocity and neuroanatomical changes in rats.* J Nutr, 1999. **129**(1): p. 207-13.
 74. Montori, V.M., et al., *Fish oil supplementation in type 2 diabetes: a quantitative systematic review.* Diabetes Care, 2000. **23**(9): p. 1407-15.
 75. Farmer, A., et al., *Fish oil in people with type 2 diabetes mellitus.* Cochrane Database Syst Rev, 2001(3): p. CD003205.
 76. Takahashi, Y., T. Ide, and H. Fujita, *Dietary gamma-linolenic acid in the form of borage oil causes less body fat accumulation accompanying an increase in uncoupling protein 1 mRNA level in brown adipose tissue.* Comp Biochem Physiol B Biochem Mol Biol, 2000. **127**(2): p. 213-22.
 77. Jones, R., et al., *Arachidonic acid and colorectal carcinogenesis.* Mol Cell Biochem, 2003. **253**(1-2): p. 141-9.
 78. Marks, F., G. Furstenberger, and K. Muller-Decker, *Metabolic targets of cancer chemoprevention: interruption of tumor development by inhibitors of arachidonic acid metabolism.* Recent Results Cancer Res, 1999. **151**: p. 45-67.