21st Century Diets ~ Stone-aged Bodies

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Introduction

Prevailing nutritional patterns of the late Palaeolithic Period, occurring 100,000 to 50,000 years ago, established epigenetic (genetically expressed) regulatory mechanisms for the human species that continue to be expressed today. These ancient dietary patterns prescribe a reference standard for the optimal health of modern-day humankind; deviation from this ancestral norm is believed to be a principal cause of the rising prevalence of degenerative disease in our modern world. [1]

During the intervening millennia, genetic evolution selectively created many observable changes to the human genome (such as hair, eye and skin pigmentation, and immune defences against microorganisms); however, core biochemical and physiological processes have remained resolutely inviolate.[2] Anthropological data from Africa, humanity's mother continent, reveal a pre-historic dietary plant-to-animal ratio of close to 1:1, with fish and shellfish comprising much of the animal component.[3] These diets, high in unprocessed plant fibre and indigenous fruits, would have been slightly alkaline, which remains the prevailing norm for modern human biology and physiology.

Archaeological evidence further reveals that, as a growing wave of humanity pressed outward from the East African plains, cultural and nutritional patterns began to diverge from this central norm. A growing discord between humankind's ancient genetic tapestry and the rapidly devolving cultural and nutritional patterns of early hunter-gatherer societies is evident in a recent worldwide study of 229 tribal societies. The findings reveal net acid loads of hunter-gatherer diets that reflect their particular geographic locations and that become progressively more positive as plant-to-animal dietary ratios decline.[4]

These profound changes in humankind's cultural and biological environments, enhanced by the introduction of agriculture and animal husbandry about 10,000 years ago, were further magnified with the arrival of the industrial revolution. According to Cordain and co-workers, such paradigm shifts occurred too recently and too swiftly on an evolutionary scale for the human genome to adapt.[5] They contend that, in conjunction with this growing discord between our ancient biology and the prevailing nutritional and cultural patterns of contemporary populations, many of the so-called diseases of civilization have emerged [6] — consequences of 21st Century diets and Stone-Age bodies.

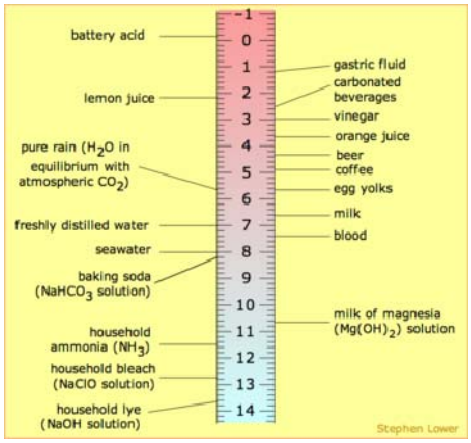
Dietary Acid/Alkaline Balance

The Neolithic (9500 BCE) and industrial periods altered seven functional characteristics in our ancestral diets that have proved detrimental to the wellbeing of modern humankind. These include: glycemic load; fatty acid composition; macronutrient composition; micronutrient density; sodium-potassium ratio; fiber content; and acid-alkaline balance.[5] This position paper will focus on a principal factor, the increased net acid load of modern diets and its health implications; within this context, the relevance of other dietary factors will be discussed. We will also review two disease processes, osteoporosis and cancer, and the role played by chronic acidosis in their etiology.

What is Net Acid Load?

The acidity or alkalinity of any solution is determined by the relative concentrations of hydrogen (H^+) and hydroxide (OH^-) ions within the solvent and is expressed as pH, meaning "**p**ower of **H**ydrogen." The pH of a solution is a mathematical calculation based on a logarithmic scale from 0-14, where 7 is neutral ($pH = -\log [H^+]$). This is the pH of distilled water, where the relative concentrations of H^+ and OH^- are equal, as represented by the following chemical equation.

$$\mathbf{H_20 \leftrightarrow H_{(aq)}^{+} + OH_{(aq)}^{-}}$$

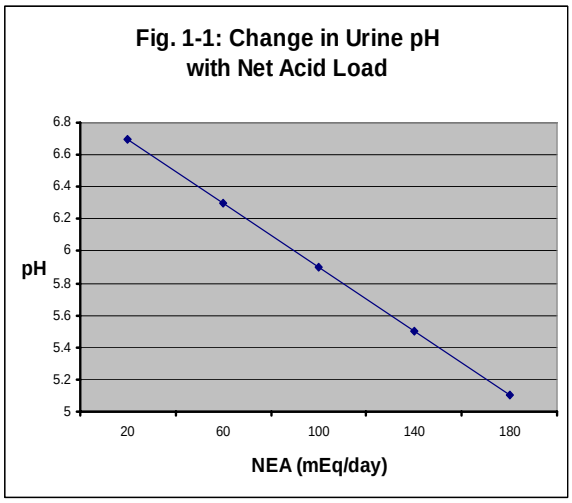


For every unit *below* pH 7.0, the concentration of H^+ increases by a factor of 10. Such solutions are said to be acidic. For every unit *above* 7.0, the concentration of OH^- is increased similarly. Such solutions are said to be alkaline. For example, a can of cola has a pH of about 2.5, over 10,000 times the acidity of the human cell. All living cells *must* operate within strict confines of a physiological pH that is slightly alkaline. Human blood, for example, has a pH of 7.365. If it drops below 7.0 (acidemia) or rises above 7.8 (alkalemia), coma and death can quickly follow. Consequently, the human body does *everything* in its power to ensure that the pH of its tissues remains within stringent confines.

Net acid load is an expression that refers to the contribution of acid (H^+) to the cells of the body from foods that are consumed. As such, it represents the total *body burden* of dietary acid. A net acid load of zero would imply that the foods eaten were exactly balanced in their relative acidity and alkalinity. While our ancestral diets were slightly alkaline, today's modern Western diet has a high net acid load. This has severe implications for long-term health.

What is meant by acid-foods?

People frequently confuse the *acidity* of a food source with its *acid load*. It appears paradoxical, but a lemon (which is quite acidic) will actually *reduce* the body's acid load, once its mineral contents (generally found in the pulp) are absorbed into the body fluids. This is because the predominant minerals within the lemon (i.e. the electrically positive cations of calcium, potassium, sodium and magnesium) have an alkalizing (acid-reducing) effect on the body. They do this by forming mineral hydroxides and carbonates in our cells, which act like molecular sponges to "suck up" excess acidity. Most fresh fruits and vegetables are replete with health promoting alkali minerals, which is in part why countless epidemiological studies have substantiated their health promoting effects.[7] Other minerals, including some found in the amino acids and proteins consumed in our diet, are *acid promoting*. These negatively charged anions (chloride, sulfate, phosphate, nitrate and some sulfur-containing amino acids) draw hydrogen into solution to form hydrochloric, sulfuric and phosphoric acids, and assorted weak organic acids in our cells. Foods that are predominant in these elements are commonly called acid-foods because they *contribute* to the body's net acid load. To determine if a particular food is acid absorbing or acid yielding, the food is completely oxidized to collect its mineral ash, then mixed with water to measure the resultant pH. The ash consists of the combined mineral contents of the food.



When organic matter is consumed, digestive enzymes cleave the constituent proteins, carbohydrates, fats and nucleic acids into their basic building blocks for absorption from the gut into the blood. All materials absorbed into the blood pass through the liver for detoxification inspection, ultimately reporting to the kidneys; it is here where the blood's pH is continually monitored and adjusted.[8] At the cellular level, dietary constituents are further oxidized by complex respiratory pathways, or are used to manufacture other structural components for the cell. During these metabolic exchanges, compounds containing sodium, potassium, magnesium, calcium, nitrogen, sulfur, chlorine and phosphorus are formed that can also contribute to the net acid load of the cell.[9]

A more accurate means of calculating the net acid load of a diet consists of directly measuring the acid and ammonium in the urine, then subtracting the measured level of bicarbonate (HCO_3^-) to yield a NEA (net excreted acid) score.[10] The NEA provides a measure of the *total* acid load of a *mixed* diet that is contributed to the body.

The NEA correlates closely with the pH of the urine as measured by narrow-range pH paper, something that can easily be done at home.

Figure 1-1, adapted from Remer and Mantz (1995),[11] shows how one can estimate the body's NEA by simply measuring the pH of the urine with narrow-range pH paper. Low protein diets or those high in vegetables and fruits will provide a low acid load, whereas high protein diets or those with a paucity of fruits and vegetables will have a high acid load. This is reflected in the milli-equivalents (mEq) of total acids excreted per day.

Another index, called PRAL (potential renal acid load), provides an estimate of the net acid excretion for an *individual* food source.[12] Using detailed charts, it is easy to identify the contribution of an individual food source to the total body burden of acid contributed from the diet. Table 1-2 provides a summary of PRAL values by food group, as reported by Remer and Manz.[11] Using the PRAL values, it is possible to estimate the acid load per 100 grams of an individual food or food group.

Table 1-2: Food group/100g	**PRAL (mEq/day)**
Processed Cheeses	**31.5**
Hard Cheeses	**21.4**
Soft Cheeses	**10.0**
Meats & Meat Products	**9.5**
Cottage Cheese	**8.7**
Eggs (whole)	**8.2**
Low Protein Cheeses	**8.0**
Fish	**7.9**
Pasta	**7.2**
Grain products (n/i pasta)	**5.2**
Nuts and Fruits	**4.5**
Yogurt	**1.4**
Sugars/sweets	**0.8**
Milk	**0.7**
Legumes	**0.5**
Fats and Oils	**0.0**
Vegetables	**-3.2**

As adapted from:
Remer and Mantz, 1995 July;95(7):791-7.

Chronic metabolic acidosis

The role of nutrition in pH homeostasis (balance) has been a subject of controversy for almost a century. Physiological research demonstrates that the prodigious capacity of the kidneys to excrete excess acid precludes any direct measure of changes to acid-base balance due to diet. In healthy individuals fed diets that create a 10-fold increase in their acid load, changes in blood pH are barely detectible, confirming the textbook knowledge of full compensatory balance.[13] However, this tenacity of the blood not to deviate from its physiological norm does not preclude the possibility of a net retention of acid somewhere within the body, or the ability of the body to draw down its mineral stores in order to replace alkalizing minerals lost in the excretion of excess acid.

The pH of the blood and extracellular fluids bathing our cells is one of the most tightly regulated processes in human physiology.[14] Even minute changes to the pH of these fluids invoke powerful regulatory responses necessary for our survival. In the blood, these responses involve the release of excess carbon dioxide (a volatile acid) from our lungs, the utilization of bicarbonate buffer (HCO_3^-) to mop up excess acid, and the formation and

removal of ammonia through our kidneys (urine) and skin (perspiration). Within the cells themselves, the buffering role falls principally to the phosphate (PO_4^{-3}) buffering system. About 85% of the phosphate ions used in intracellular pH buffering comes from potassium phosphate deposits on our bones and teeth.[15]

Normally, these homeostatic responses are more than sufficient to deal with the day-to-day production of acids from cellular metabolism and return our cellular fluids to a slightly alkaline pH. Even in situations of extreme metabolic stress, where the body is forced to generate large quantities of lactic acid (such as in running a marathon), these regulatory mechanisms will soon return the pH to normal. However, if excess acid is continually introduced — either through pathological conditions or through the diet — a state of low-grade, chronic metabolic acidosis will occur.

To preserve pH balance under conditions of chronic acid load, the body must continually draw on its alkaline reserves by releasing calcium, potassium and magnesium from the bone matrix to neutralize excess acid. In addition, the body begins to break down muscle protein in order to release the amino acid glutamine. In turn, glutamine is converted to glutamic acid (glutamate) by the liver and, in doing so, binds with excess hydrogen ions to generate ammonia (NH_4^+). The ammonia is then excreted in the urine, along with chloride (Cl^-) ions that are needed to balance the electrochemical charge.[16, 17]

$$\textbf{Glutamine} + H^+ \leftrightarrow \textbf{Glutamate} + NH_4^+$$

These two catabolic processes, if unchecked, result in the gradual loss of protein, calcium and related alkali minerals from the bone (osteopenia), and progressive muscle wasting (sarcopenia), both of which are age-related degenerative processes.

The fact is, low-grade (sub-clinical) chronic metabolic acidosis does exist normally in humans eating ordinary diets that yield normal net rates of endogenous acid production. Furthermore, this phenomenon has also been observed in other animal species.[18, 19] The degree of acidosis increases with age, which explains the gradual decline in skeletal and muscle mass that occurs with aging.[20] If you have ever noticed the pungent aroma in a seniors' center, it is likely from the high levels of ammonia excreted in the urine of the acidotic residents.

Mainstream medicine has yet to recognize chronic metabolic acidosis, except as can occur through serious illness, such as diabetes and cancer. The heated debate amongst medical practitioners (who claim it is impossible to acidify the blood, except in the case of life-threatening disease) and the scientific research community (who finds otherwise) overlooks a simple misunderstanding. Acidosis is a *process,* not an end-game; like the voltage

potential of a charged battery, acidosis is the electrochemical force that attempts to *drive* the pH of the blood *toward* acidity. Only if not countered by the prevailing regulatory mechanisms of the body, will the end-game — *acidemia* (acid blood) — inevitably result.

As previously mentioned, compared to our ancestral diets, which were alkaline preserving, the modern Western diet is acid producing. Research by Sebastian and coworkers shows that the NEA of the ancestral diet was approximately -88 mEg/day, as compared to +48 mEq/d for the Western diet.[21] While many proponents of alkaline (vegetarian) diets cite the high protein intake of the contemporary diets as the main contributor to acid load, the role of proteins in pH balance is exceedingly complex and dependent on the specific amino acid content of the protein(s) in question (plant protein vs. animal protein). A high protein intake *can* be acid forming, due to the phosphate and sulfur groups found in the amino-acid building blocks of animal proteins; however, protein degradation can also counteract some of its own acid load by increasing the renal capacity to excrete excess acid (as mentioned previously with glutamine). Thus, it appears that the shift from alkaline to acid load may come largely through displacing the bicarbonate-yielding fruits and vegetables with acid-yielding grains and dairy products.[8] In other words, it may not be so much an *excess* of acid-producing foods, but a *paucity* of alkaline-yielding vegetables that tips the scale from a healthy alkaline diet toward one of chronic metabolic acidosis.[22]

Chloride Balance

This paper reports another important regulatory mechanism that appears to have been largely overlooked in the ongoing debate about chronic acidosis: the significant contribution by sodium chloride — more specifically, the role of the chloride ion (Cl^{-1}), itself — to the net acid load of the body. Evidence of such participation has been very recently reported by Frassetto and coworkers, of the University of California, who found that the concentration of NaCl in the blood can *independently* predict the acid-alkaline status of the body.[23] The authors contend that, depending on the level of dietary intake, the concentration of chloride in the blood can predict a startling **50-100%** of the acidosis-producing effect of the diet. This finding is supported by the earlier work of Kellum and others, whose investigations into the determinants of blood pH concluded that it was the relative concentration of chloride to other strong ions (known as the strong ion difference) — and *not* the level of bicarbonate (HCO_3^-) buffer — that determines the level of acidosis.[24, 25] According to Kellum, the chloride ion can *singularly* act as a strong base, drawing hydrogen into solution. Consequently, as the level of chloride increases, so too does the level of acidity (pH decreases).

A typical American diet contains amounts of sodium chloride *far above* evolutionary norms and potassium *far below* those norms. It is estimated that our ancestral diet had a potassium/sodium ratio of 10:1, which has now been inverted to 1:3, reflecting a 30-fold

change.[26] This inverted ratio of potassium to sodium in our contemporary diet, compared to our ancestral diet, is known to adversely affect cardiovascular function and contribute to hypertension and stroke. The very recent finding that diets containing substantial sodium chloride and diets that are acid producing can act *independently* to induce and sustain increased tissue acidity suggests a potent "tag-team" combination, enhanced by increasing age and the kidney's impaired ability to excrete excess acidity.[27, 28]

These findings have huge implications, considering the amount of salt in the human diet, and suggest that sodium intake may play a role *equal* to or *greater* than net acid load of *all* other nutrients in the process of acidosis.

Acidosis and Disease

The great French scientist, Louis Pasteur once said, "The germ is nothing, the inner terrain is everything." Within this context, chronic metabolic acidosis represents a profound disruption of our inner biological terrain, and one that is consistently observed in most physical and mental degenerative diseases. According to some clinicians, chronic acidosis is a clinical barometer by which we can measure the degenerative process.[29]

In animal and human studies, metabolic acidosis has been shown to:

- increase Reactive Oxygen Species (ROS), impair oxidative phosphorylation (energy transfer), and invoke oxidative damage;[30-32]
- create aberrations in intestinal absorption of minerals and other nutrients;[33, 34]
- elevate insulin and cortisol levels;[35, 36]
- cause derangements in endocrine hormone balance;[37, 38]
- impair immunity and increase systemic inflammation;[32, 36, 39-41]
- reduce skeletal mineral and protein content and impair the function of bone-building cells;[42-49]
- retard skeletal growth;[50-52]
- promote proteolysis of protein and age-related muscle wasting;[42, 44-47, 53-55]
- induce hypertension and cardiovascular dysfunction;[56 57]
- decrease insulin sensitivity and promote obesity, and;[22, 50, 51, 58]

- activate critical cellular signalling molecules linked to inflammation and carcinogenesis.[59, 60]

The *real* problem with chronic acidosis may not be so much one of excessive protein intake as it is one of chronic alkaline deficiency. It is well known that the standard North American diet falls woefully short of the daily intake of the fresh fruits and vegetables needed to supply the alkalizing minerals to effect pH balance. Several studies confirm that returning to an alkaline diet closer to our physiological norm will ameliorate the negative effects of excess acid load.[61-63]

Too much acid, too much salt, chasing too few minerals. It is clear that today's dietary patterns are in serious discord with our genetically prescribed needs. As a society, we have neglected and abused our 'biological terrain' and degenerative disease is the consequence of our folly.

Osteoporosis

To protect at all costs the pH balance of the blood, the body sacrifices bone tissue through direct chemical dissolution of the bone surface, conscripting the minerals as buffers against the corrosive effects of excess acidity. As little as one week on a mildly acidic diet is sufficient to show a detectible drop in bone minerals from the bone surface.[64]

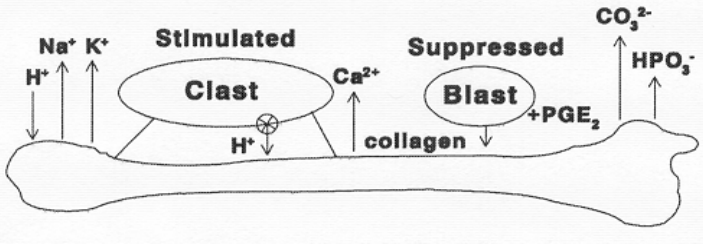


Fig 1-2: Metabolic acidosis. Schematic diagram of the mechanisms by which excess H^+ leads to release of bone calcium and other buffering minerals during chronic metabolic acidosis.
Clast = osteoclast, Blast = osteoblast

From: Bushinsky DA, *Eur J Nutr*. 2001;40:238-244

Consequently, acid-producing diets can dramatically alter both bone structure and function. A high dietary acid load has been shown to both *increase* bone resorption (a process by which the bone structure is remodeled) and *decrease* bone formation.[65]

In the process, calcium (Ca^{+2}) and carbonate (CO_3^{-2}) are released from the bone mineral matrix.[65, 66] This release of calcium into the blood and its excretion in the urine is *not* compensated by equivalent calcium uptake in the gut. Sodium (Na^+), potassium (K^+), and assorted phosphate (PO_4^{-3} and HPO_3^-) ions are also released from the bone surface to combine with the excess hydrogen (H^+) in the blood.[67-69] Unchecked, this degradative process leads to thinner, weaker bones (osteopenia) and, if not corrected, osteoporosis (hollowed out bones).

It begins with the release of the alkaline minerals sodium and potassium from the bone surface, which the blood uses as its first line of defense against excess acid. Failure to restore pH balance then stimulates osteoclast (bone-destroying cells) activity and shuts down osteoblast (bone-forming cells) activity, precipitating the release of calcium and the carbonate/phosphate buffers from the bone mineral matrix and the increase of calcium (hypercalciuria) in the blood.[65] Arnett and coworkers have shown that bone resorption by osteoclasts is absolutely dependent on extracellular acidification; these cells are inactive at alkaline pH levels (above 7.3) and show maximum stimulation at a pH of about 6.9. Resorption is most sensitive to changes in acidity at a pH of about 7.1 (close to the interstitial pH in bone).[70] This cell-mediated response is likely affected through the release of the stress-related hormone cortisol, high levels of which are known to concurrently deplete muscle protein and accelerate mineral loss (a likely reason why prolonged stress, which raises blood cortisol levels, will accelerate bone loss).[35]

Researchers with the massive Framingham Osteoporosis Study, published in 2001, contend that the consumption of fresh fruits and vegetables is a prudent means of interrupting this bone destroying process.[71] Because fruits and vegetables metabolize to bicarbonate, investigation has recently turned toward supplementation of the diet with alkaline salts, such as potassium bicarbonate and potassium citrate.[72, 73]

Maurer and coworkers (2003) were the first to demonstrate that even very mild diet-induced acidosis will lead to the destruction of precious bone mineral, an effect that could be immediately and significantly reversed with the administration of bicarbonate mineral salts.[35] The treatments are generally well tolerated and help replenish the body's alkaline reserves while also serving to reverse the dysfunctional potassium/sodium ratio characteristic of modern diets. In one study, neutralization of dietary acid load using potassium bicarbonate ($KHCO_3$) supplements improved calcium and phosphorus balances, reduced bone resorption, improved nitrogen balance (through reduced muscle wasting) and helped mitigate the normal age-related decline in growth hormone levels.[19] Other investigations demonstrate the remarkable bone preserving effect of this simple mineral salt. Dietary intervention with potassium-rich and bicarbonate rich foods and $KHCO_3$ supplements confer striking protection against the bone-wasting effects of today's high-acid Western diet.[74-77] $KHCO_3$ supplementation can also reduce hypertension and risk of stroke, prevent kidney stones by reducing calcium excretion, and protect against osteopenia and osteoporosis by increasing the retention of calcium and phosphorus, reducing bone resorption, and enhancing bone formation.[78] The dose of bicarbonate required to provide skeletal protection was found to be 60-120 mg/d, or about 1-2 teaspoons of potassium bicarbonate each day.[79]

Cancer

In his elegantly written documentary, *Anticancer ~ A new Way of Life,* physician, researcher and cancer survivor, David Servan-Schreiber, paints a startling exposé of mainstream medicine's abject failure to address the true causes of cancer.[80] He contends that it is our modern Western diet and lifestyle that acts as a 'fertilizer' for cancer, helping to prepare our biological terrain for the incursion of this deadly process. According to Servan-Schreiber, the disease can best be understood as a breakdown in the balance between pre-cancerous cells that lie dormant in our bodies and our own natural defenses, which normally keep them at bay. By preparing the 'soil' with diets that are highly glycemic and highly acidic, these cancerous seeds germinate and morph into fast-growing clusters of mutated cells that soon become immortal and divide without end, spreading a growing tsunami of hyper-acidity that kills normal cells to make room for the new kids on the block. He argues that our best defense is a good offense, through simple and practical dietary and lifestyle changes.

Servan-Schreiber's arguments are well supported by a wealth of epidemiological and clinical studies, which confirm that more than 60% of cancer deaths can be avoided by simply adopting healthier lifestyles.[80-82] A very recent study demonstrated that women with breast cancer that had already spread to the lymph glands (metastasized), and whose treatment focused on diet, lifestyle change and stress reduction, saw their risk of dying from cancer drop a remarkable 66% compared to those women who chose the conventional treatments of "cut, burn and poison." [83-86] As well, researchers at the Université de Montréal confirm that high fruit and vegetable intake diminishes the risk of breast cancer in genetically-prone, high-risk individuals by a stunning 73%. It seems that an alkaline diet confers the ability to down-regulate the cancer-causing genes that can lead to the development of this type of cancer.[87]

In a study of 93 men with prostate cancer who refused conventional treatment and chose instead to modify their diet, exercise habits and stress levels, researchers found a marked reduction of their levels of prostate specific antigen (PSA), a blood marker for prostate cancer. Moreover, their blood was *7-fold* more capable of inhibiting cancer growth than those seeking conventional treatment.[88] In a very recent study, the same researchers found that such lifestyle changes modified the expression of more than 500 genes within the prostate, stimulating the cancer-protective genes and inhibiting cancer-promoting genes.[89]

Such strong evidence begs the question: What is it about our Western diet that seems to kick-start the cancer process? While a growing volume of observational, clinical and epidemiological evidence points to the role of chronic tissue acidosis in the genesis and maintenance of cancer,[90] a review of the literature on acid-forming diets and cancer reveals a

paucity of research. The vast majority of cancer studies are looking through the *wrong* end of the microscope — focusing on treatment/cure rather than prevention and risk mitigation. Nobel Laureate James Watson (co-discoverer of the molecular structure of DNA), describes today's cancer industry as, "intellectually bankrupt, fiscally wasteful and therapeutically useless." However, recent studies *have* emerged that provide an intriguing insight into the relationship between diet and cancer.

As previously mentioned, an acid-promoting diet initiates a broad cascade of biochemical and physiological changes to our inner terrain that appear to set us up for cancer. These include: chronic oxidative stress, enhanced catabolism (muscle wasting and destruction of skeletal reserves), elevation of insulin and cortisol, systemic inflammation, obesity, and impaired immunity. Each of these aberrations is known *singularly* to be involved with the genesis of the cancer process. Just imagine the implications when they are *all* pulling on the same rope.

Cancerous cells are formed continuously in the human body, with an estimated 10,000 cells active at any given time, their growth normally kept in check by an active, healthy immune system.[91] Abnormalities in our acid/alkaline balance seem to play a major role in the genesis of cancer by knee-capping our immune response to allow cancerous growths to start.[32] The glucocorticoid hormone, cortisol (responsible for the muscle wasting and bone depleting effects of chronic acidosis) is well known for its inhibitory effects on our immune system and is over-expressed in highly acidic tissues.[36] High levels of inflammation also block the body's natural defenses by disarming its natural killer (NK) cells (specialized white blood cells) and enhancing the production of chemical signalling molecules, such as prostaglandin E2 (PGE2), to further inhibit immunity and encourage unchecked growth.[92, 93] Measuring the level of systemic inflammation can, in fact, predict a patient's survival time for several cancers.[94-96]

It was the father of modern pathology, Rudolph Virchow, who first observed that people often develop cancer at the exact spot where they had sustained an injury. Virchow advanced the hypothesis that cancer was a wound repair that had gone awry. The finding that cancer is most often directly related to a chronic inflammatory state adds support to Virchow's position, as inflammation is intricately related to the healing process.[97] Cancer, in fact, requires inflammation to both initiate and sustain its growth. For this reason, cancer cells secrete inflammatory proteins and other signaling molecules seen in natural wound repair, to fuel their growth.

Yet the unchallenged growth of cancer appears to rely principally on a single pro-inflammatory agent present in all cells but highly expressed in cancer cells — Nuclear factor

kappa-β (NFkβ) — the 'master switch' that regulates inflammation throughout the body. Once activated, this cellular protein migrates to the nucleus of the cell, where it can switch on over 400 genes that control the body's inflammatory cascade.[98] According to Albert Baldwin, of the University of North Carolina, almost every cancer agent known to pharmacology is an inhibitor of NFkβ. In fact, the entire industry focus appears intent on finding an appropriate drug that will expressly inhibit this critical biochemical trigger.

Simply put, you could not find a better way to set us up for systemic inflammation and cancer than our acid-forming Western diet. Systemic tissue acidity (pH ~ 7.0 or less) has been shown to switch on NFkβ and other inflammation-signaling chemicals, such as C-reactive protein.(CRP) and cyclooxygenase-2 (COX-2), an enzyme central to the manufacture of other important inflammation-signaling molecules.[32, 99] At the same time, hyper-acidity within the tumor site (assisted by an already acidic condition) further cripples the immune system by knocking out of action the specialized white blood cells responsible for culling aberrant cells.[100-102] Acidification of tissues through imprudent dietary and lifestyle choices appears to tip the scales in favor of harm, *enslaving* our innate immune responses, which would normally swing into action to search out and destroy these invasive growths.[36]

While the pH of cancer cells is neutral to slightly alkaline, the pH of the fluid surrounding these cells (extracellular fluid) is highly acidic due to acids secreted by cancerous cells, conferring upon them the ability to invade. Recent studies show that the administration of potassium and sodium bicarbonate salts can markedly enhance cancer kill rates and arrest cancer growths.[103-105] Other investigations have shown that interfering with the over-expression of carbonic anhydrase, an enzyme responsible for acidification of the tumor through conversion of bicarbonate to carbon dioxide (thereby removing the buffering effect of HCO_3^-), can attenuate the invasiveness of cancer.[106-110] Some practitioners are now beginning to use bicarbonate therapy in their clinics, with remarkable results,[110] supporting the argument that it is a lack of bicarbonate and other alkalizing nutrients in the diet that predisposes us toward cancer and other degenerative processes.

Conclusions

Oxidative stress, insulin resistance, cortisol-induced catabolism, systemic inflammation — *all* are consequences of a diet and lifestyle out of sync with our genetically prescribed patterns. They work synergistically to alter the body's ancestral biological terrain, defeat its natural defenses and dramatically increase our lifetime risk of cancer, osteoporosis, and other serious chronic diseases. The good news is that we can control these risk factors *ourselves*, with appropriate diet and lifestyle changes, so that the threat of these and other degenerative processes need not loom so large.

The following are some suggestions for kicking the 'acid' habit, returning your body to a healthy alkaline balance, and reducing your lifetime risk of degenerative disease, which unnecessarily cuts short so many lives today:

1) bring pH balance back to the dinner table by serving meals that consist of 60-80% alkalizing fruits and vegetables;

2) stir-fry or steam your vegetables to preserve mineral and vitamin content, which is usually lost from overcooking and boiling;

3) Reduce your reliance on acid-producing dairy products, particularly hard cheeses, which should be used as condiments only;

4) Seriously reduce your use of acid-promoting white flour and substitute with multi-grain flour;

5) Start each day with an alkalizing glass of lemon water by squeezing a fresh lemon (NO SUGAR) into pure water — and make sure you include the pulp;

6) Drink 6-8 glasses of water each day to help flush acidic wastes out of the body;

7) Choose fresh fish and organically grown chicken over red meats and limit your protein intake from meat to about 4 ounces a day (about the size of a deck of playing cards);

8) Throw out your sugar bowl — really;

9) Trade in your table salt (sodium chloride contains traces of over 6o chemicals from the refining process) and choose natural sea salt, which contains a mixture of alkaline mineral complexes;

10) Don't drink sugary sodas (a single can of cola contains over 9 teaspoons of sugar and requires 32 glasses of water to neutralize its acidity);

11) Increase your intake of inflammation-reducing omega-3 fats, found in fish and flax seeds, and reduce your intake of inflammation-promoting omega-6 fats found in vegetable oils, fatty meats and dairy products;

12) Get some exercise every day, preferably aerobic exercise, to blow out excess acid-producing CO_2 from your tissues and help maintain muscle tone; and,

Lastly, learn to chill out, laugh and love a little more. Stress relief is now understood as a vital component of reducing tissue acidity and inflammation and protecting your long-term health.

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