Chapter 5

Nutrition and Health

"Eat to live, and not live to eat."

Benjamin Franklin

"…the investigation of the science of nutrition – a subject so curious in itself, and so highly interesting to mankind, that it is truly astonishing it should have been so long neglected…"

Sir Benjamin Thompson (Count Rumford) quoted in *But the Crackling Is Superb,* edited by N. and G. Kurti, Adam Hilger publishers, Bristol

A Growing Concern

Knowledge that food is good for you is not new. Early humans certainly knew that the absence of food for long periods of time meant starvation and ultimately death. A successful hunt or a plentiful harvest determined whether the community survived periods of scarcity or not. That much knowledge prevailed before there was awareness of the importance of the macronutrients, the micronutrients, and now the biologically active non-nutrients which have some effect on the health of the human body.

Prevalent diseases that the early population suffered are recorded by Durant (1957); amongst these were gout, rheumatism, dropsy, and diseases of eyes and skin, all very likely due to, or abetted by, poor nutrition. Nutrition was supplied by a "heavy diet…with alcoholic drinks" (Durant,

1957) (see also, Table 1.3). Life expectancy (1340) was such that few people reached more than 40 years of age and fewer still lived beyond 50 years of age (Durant, 1957).

What was not generally known in these early centuries was that a particular quality of food, its nutritional value, was an important factor in both health and longevity. They were not aware that food contained essential factors for the normal, healthy functioning of the body. That knowledge is a comparatively recent awareness in European and North American cultures.

Lind (see Table 1.3; Singer, 1954), for example, published his study on scurvy only about 250 years ago citing its cause as the lack of fresh fruits and vegetables thereby providing the cure, but not the curative factor, for scurvy. More than a hundred years later, Takaki (Itokawa, 1976) established food as a factor in beriberi but again the causative component remained unknown. Hopkins (Hawthorn, 1980) at the turn of the 20th century produced the first report on that important group of micronutrients, the vitamins. Then, in fairly rapid succession the many different vitamins, important co-factors (such as the minerals), and vitamin-like components of food were discovered. The role and importance of protein and amino acids in the diet were elucidated. The value of fat and the essential fatty acids in the healthy maintenance of the body was revealed. Nutritional knowledge of the value of both the macro- and micronutrients has grown enormously since the first vitamin was isolated and identified.

That the prevention of diseases such as cancer and heart disease could be related to the consumption of a variety of foods variously called functional foods, nutraceuticals, pharmafoods, nutricines, or medifoods, or to factors which are found in such foods, is an even more recent development. It is one branch of nutrition that is undergoing intense study and unfortunately vigorous exploitation by scientists, by the food industry, and by the media.

The claims for such foods are that when they are a significant part of the diet they promote good health, strengthen the body's immune system and consequently contribute to the body's ability to fight diseases. Fiber was one of the earliest such components touted. It was alleged to reduce cholesterol in the blood and to play a role in the prevention of colon cancers and some other cancers. Food manufacturers were quick to jump on the bandwagon and have used fiber, extracted from whatever previously waste plant byproducts that might contain fiber, to develop new products with implied anti-cancer or cholesterol-lowering properties.

There is now a blurring of the distinction between medicine and food with a consequent nutritional and legislative confusion between the two areas. Grocery shelves and drugstore shelves are merging into one big conglomerate where health foods and healthy foods are becoming gray

areas. The result has been a labeling nightmare as some herbal folk medicines become mainstream ingredients used to fortify many products from breakfast cereals to beverages.

The Nutritional Sciences

Nutrition's role in the proper functioning of healthy bodies and in the prevention of nutritional deficiencies is now appreciated and recognized. The mechanisms of how this is accomplished, however, are not completely understood. Scientists, for example, do not agree on how some of the micronutrients create the reactions that are attributed to them.

The role of these components in the prevention of specific diseases is not at all well understood. Nor is it clearly established that all claims made for these foods containing these components are true.

The subject area of greatest interest to nutritionists is now the elucidation of mechanisms by which diet is a factor in one's well-being. They are now concerned with:

- The importance of nutrition in the performance of human beings under extreme stress as in manned space flight, in military operations, in post-operative recuperation (enteral foods), in radiation therapy, intense athletic endeavors, etc.
- How diet and one's genetic make-up interact to influence one's health. An individual's genetic make-up may greatly influence absorption, metabolism, and gene expression.
- The action of non-nutrients in shaping and influencing the body's defense mechanisms or its physiological or mental state.

Nutritionists are now focusing on preventive nutrition. Food manufacturers are pushing products that can capture the marketing potential that preventive nutrition represents. When the ten leading causes of death are believed to be either diet related or to have diet play some role in their etiology (Belem, 1999), then nutrified products certainly have market potential.

In fact, the market potential for such health(y) foods is enormous (Belem, 1999):

- The U.S. market for health foods, dietary supplements, low-calorie low-fat foods, and nutraceuticals may be greater than $250 billion per year.
- In Europe there is a similar market potential of $250 billion per year. Europe has a more mature market that is more used to yogurts and other cultured dairy products as well as herbal remedies.

- Japan's market is estimated at $60 billion per year.

Preventive maintenance foods, therefore, represent an important research area for nutritionists and for food technologists for developing new products to satisfy the needs of the public in the third millennium. Dietary regimens directed toward preventive nutrition will inevitably lead to what already have been called "designer foods." These are products formulated with biologically active non-nutrients and designed to prevent (a more accurate term would be "to play a role against") specific diseases or to maintain a healthy lifestyle.

The Macronutrients

Proteins, fats, and carbohydrates are important both quantitatively in the diet and as carriers for the essential micronutrients. Due largely to caloric content, overabundance and underabundance of the macronutrients are concerns for people's health; too many calories lead to obesity in the individual and too few calories result in under-nourishment. Both have serious health implications.

The quality of the macronutrients is important. A complete complement of the essential amino acids, the basic building blocks of proteins, is needed. Animal proteins are considered to be higher quality in this respect than are vegetable and cereal proteins. Intense research in cross-breeding and genetic engineering is being conducted to increase both the protein content of cereals and the quality (i.e., the completeness) of the protein contained therein.

Dietary Fats

The public has been encouraged to reduce the amount of fat in the diet such that 30% or fewer of the total calories come from fat. This reduction, in large measure, has been accomplished. Paradoxically this has not reduced the number of overweight or obese people in developed countries. Now there is suggestive evidence of a virus that may cause some people to gain weight (Holmes, 2000).

From the amount of fats or the amount of calories due to fat in the diet, concern now has switched to the kinds of fat that are consumed. For several years, nutritionists have exhorted consumers to reduce their intake of animal fats. The reason was to limit the intake of preformed cholesterol found therein. Next, nutritionists wanted consumers to reduce the amount of saturated fats in the diet and correspondingly increase the amount of vegetable oils, unsaturated fats, consumed. This again was a

hit against the amount of animal and saturated vegetable fats (palm oil and coconut oils) as major components in the total fats consumed.

There emerged the physiological need for the essential fatty acids in the diet. They were implicated in prostaglandin synthesis and hence disease resistance and in heart problems.

The consequences are somewhat of a dilemma for consumers. For good health, calories derived from fat should be kept low. But fats are a vehicle for the fat-soluble vitamins and their component fatty acids are essential in the diet. The essential fatty acids are the mono- and di-unsaturated acids. Thus, the consumer is asked to regulate the amount of fat intake while maintaining an adequate supply of fat-soluble vitamins and essential fatty acids. Now it is strongly suggested that reducing the amount of fats in the diet is not necessary. Eating the right balance of ω-3 and ω-6 containing fats is more important (Neff, 1998).

Obesity and Disease

The fleshy female figures of earlier years as depicted by Rembrandt's Bathsheba or by Goya's voluptuous Naked Maja, or abounding in a Rubens picture are definitely out in today's fashions. Thin is in and fat is out. Or is it? A walk along any city street in a North American city will reveal that a very large percentage of one's fellow citizens are not just fat but obese. While fashions may come and go respecting the shape of the human body, the rapidly accumulating scientific knowledge backed by statistical studies on large populations indicates that the overweight condition is unhealthy.

And expensive. Birmingham et al. (1999) studied the direct health care costs of obesity-related illnesses (cardiovascular disease, hypertension, diabetes, and certain cancers) in Canada in 1997. Coronary disease accounted for $\$346 \times 10^6$, hypertension $\$656.6 \times 10^6$, and obesity-related diabetes $\$423.2 \times 10^6$ in 1997 alone. At that, the researchers consider this figure to be too low since diseases having multiple causes not linked solely to obesity were not included in their study.

The health and social problems associated with obesity are detailed more comprehensively by Lachance (1994). In addition to the cost element of obesity (Birmingham et al., 1999), obesity is a factor in

- Gout
- Obstructive sleep apnea
- Hyperlipidemia
- Osteoarthritis
- Reduced fertility and impaired obstetrical performance
- Increased risk of accidents due to reduced physical agility

There are also social and psychological problems associated with obesity: discrimination and prejudice against individuals because of their obesity. Obese or simply overweight individuals feel stressed in a culture that values slimness. Such stress can foster in its turn a host of psychological problems in some individuals. Antipathy toward obese individuals can often lead to reduced economic capacity of the obese population. Employers are reluctant to hire the obese because of their proneness to accidents, their inability to perform certain tasks, and their greater incidence of illness causing absenteeism.

The soaring costs of obesity, both direct and indirect, have attracted the attention of governments. The World Health Organization, for example, holds obesity as a serious worldwide epidemic. A Reuter's news dispatch quoted Dr. Philip James, chairman of a WHO task force on obesity at a congress held in Spain (Anon., 1996) as saying,

> *"Obesity is doubling every five years so we have an epidemic that is coming at the health service like a tidal wave… a disaster on our hands."*

Obesity is on the rise in North America (Neusner, 1999) despite a proliferation of food products that are low fat, contain no fat (using fat mimetics), or are reformulated using synthetic fats (fats which are not absorbable by the body but have fatty organoleptic characteristics), for example:

- Car seat manufacturers have had to make seats for trucks, large cars, and sports-utility vehicles larger. Airplane seats are being made with higher drop-down trays that do not catch the bellies of larger passengers. More seat belt extensions are required on flights.
- Government surveys show that 50% of U.S. adults are overweight and 33% are actually obese. Approximately 50% of women in the U.S. wear clothing size 14 or larger. The average daily caloric intake is up for all ages of men and women since 1990, 11 and 6%, respectively. In Canada, approximately 33% of adults are categorized as obese (Birmingham et al., 1999).

Statistics on the overweight condition and definitions for obesity vary widely as there is no universally accepted definition of either overweight or of obesity. Lachance (1994) discusses some of the methods of measurement of these conditions and their various shortcomings.

The costs and the associated health and social problems of obesity cannot be expected to lessen without the active cooperation of government, nutritionists, and food manufacturers. But most of all the general

public must adopt good eating habits. These can only be inculcated into the mature public through education in food, nutrition, and health while people are youngsters.

Where obesity is a problem and medical costs have soared as a result of health problems caused by obesity, governments of developed countries have reacted to the problem of obesity in various ways. They have:

- Introduced nutritional labeling of food products to guide consumers in their purchases;
- Relaxed laws regulating the health claims that food manufacturers can make for their reduced calorie products or designer foods;
- Ruled on the safety of non-nutritive intense sweeteners or fat mimetics, extenders, or synthetic fat-like substitutes as additives; and, on a more positive note,
- Promulgated and promoted new food guidelines for consumers.

Some vested interest groups have been highly critical of many of the recommendations; for example, decreasing consumption of animal proteins in favor of more fruits and vegetables has annoyed the cattle ranchers.

The success of these measures must be measured by the general growth of the population of the developed world:

- Fatter rear ends
- Soaring costs of more diseases directly attributable to the overweight condition
- Increasing consumption of calories combined with a more sedentary lifestyle

In short, these efforts have been rather disappointing.

At the same time that governments published their nutritional guidelines and required nutritional labeling, they were reducing grants to health education and other social programs which could have complemented these efforts.

The food industry responded to the problem of obesity with an abundance of low-calorie, low-fat products. The products ranged from low-calorie beverages to low-fat hamburgers. Farmers were encouraged to raise leaner animals.

Food scientists found more areas of research as they worked to develop ever more fat mimetics out of even more exotic materials and to search for and develop low- or non-caloric substances. Scientists developed new methods to synthesize more engineered fats. At present, the search is on for substances to block appetite.

Nutritional education of consumers starting from the cradle seems to be an avenue all eschew. It is, after all, much more exciting to develop

new products or ingredients to curb appetite, or magically dissolve fat than to educate consumers and to promote a healthy lifestyle.

A Backlash?

How well have these measures worked? Apparently, after stupendous growth, sales of low-fat or low-calorie foods are either stagnant or lackluster. The diet cola market, while still a big U.S. market at $13 billion a year, has not grown substantially in 7 years. Obesity is still rampant. Obviously fat-filled food products must do better in the marketplace than fat-free or low-calorie foods in the marketplace or (*vide infra*) people are eating more of the low-calorie, low-fat foods in the false belief they confer no calories.

Neusner (1999) reports that manufacturers are responding — indeed, have been forced economically to respond — to a trend toward full-fat products (!):

- Nabisco Holdings Corp. added fat to its Snackwell's™ line of low-calorie products with the result that the falling sales of the product line stabilized.
- Ben & Jerry's Homemade Inc., a well-known North American ice cream maker, saw their full-fat ice cream sales rise 29% in its last quarter in 1999.
- Olestra™, a synthetic fat substitute from the Procter & Gamble Co., has had little impact on snack sales. Its promise has fizzled out.
- Taco Bell™ withdrew a line of low-fat fast food products it had developed. Their main consumers were teenaged boys who were not interested in fat-reduced foods.

And consumers are still not nutritionally aware or knowledgeable. Labeling and nutritional guidelines have not had a major impact on eating habits. If they had, obesity would not be the problem it still is at this, the beginning of the third millennium. The following anecdote illustrates the problem regarding nutritionally related disease:

> *A biochemist, a professor at a major university, commented to me on his passion for snacks, corn puffs, and corn and potato chips in particular. He was delighted with the coming of snacks prepared with Olestra™, a recently approved synthetic fat. He could now eat as much of his comfort foods as he wanted (which he admitted he was doing). I burst his bubble of contentment by pointing out that fat had not been the only source of calories in his snacks and further informed him that it had been reported that some consumers experienced other side effects because of Olestra™.*

Herein is the problem. Consumers, ignorant of even a basic awareness of nutrition, when confronted with an array of low-fat or no-fat products, believe that they can consume large quantities with impunity. The erroneous assumption that is made in their minds is that now they can have two pieces instead of just one!

When adults, who should know better, are so ignorant of food and nutrition and when young people are growing up with little or no food science or nutrition training or cooking experience, bad eating habits leading to nutritionally based disorders are to be expected.

Proteins and Carbohydrates

One is not too certain what to say about proteins and carbohydrates in nutrition and health. Fat alone cannot be blamed for the conditions of overweight and obesity and the problems associated with them. Both proteins and carbohydrates contribute to an overabundance of calories in the diet leading to obesity.

It is unfortunate that protein nutrition has been rather eclipsed by the attention given to its two sister macronutrients: fats and carbohydrates. Because of their high caloric density, fats are the focus of attention for attacking the problem by manufacturing low-calorie foods. Carbohydrates get attention for two reasons:

1. First, the simpler carbohydrates contribute sweetness and consumers have a sweet tooth. Hence consumers desire sweet foods; consequently, carbohydrates contribute significantly to caloric intake. The search is on for non-caloric sweeteners and non-caloric fats with which to make low-calorie food products with sweetness and with the satiety feeling contributed by fat.
2. Second, the more complex carbohydrates, the polycarbohydrates, appear to play some role as biologically active non-nutrients.

It is because of the second function that carbohydrates have garnered intense interest both by nutritionists and by manufacturers of ingredients and finished products. Fiber, a generic term for a complex polycarbohydrate, has become an important food ingredient as a biologically active material playing a role in the body's disease defense mechanisms.

Proteins have had no such fanfare to cause them to be the center of either scientific and nutritional scrutiny or manufacturing interest — barring, of course, textured vegetable proteins, but even here interest has waned. It is true that there is much genetic research in modifying cereal and vegetable proteins with respect to increasing the amount of protein

and its complement of essential amino acids. Both conventional and gene transfer techniques are being used to accomplish this enrichment.

Of some unusual interest is the amino acid L-theanine. This amino acid is found very sparsely distributed in nature but is found in comparatively large quantities in the tea plant (Juneja et al., 1999). It is found as a free amino acid; that is, it has not been found combined in protein. Its physiological action as a relaxant is explored in depth by Juneja et al. (1999). Already a commercial application, Suntheanine™, has been marketed.

The greatest concern respecting protein is not nutritional but economic and social. As developing countries become more affluent, there is a strong desire for their peoples to increase the amount of animal protein in their diets. Vegetarian diets do tend to blandness unless spiced. Animal protein, even in small quantities, provides a welcome flavorful body to such dishes.

Wherein, then, is the problem to be faced in the third millennium? The trend to greater consumption of animal protein puts pressure on the production end of the food microcosm. Already there are concerns about the dwindling stock of seafood. Political efforts are being made to get agreement between nations to stop or curb over-fishing. Environmentalists and moralists are concerned at the loss of forested land to grazing land for animals and point excitedly that it takes more, several pounds more, cereal grains fed to animals to raise one pound of meat. These grains could support more people than the one pound of meat. This issue will be discussed more fully later.

The Micronutrients: Biologically Active Non-Nutrients

Young (1996) describes micronutrients as a third generation of health foods. The first generation of products reflected the public's (or rather some of the public's) interest in healthy foods such as fruits and fruit juices, yogurts, and whole wheat breads as well as multigrain breads. This was followed by the second generation of food products best described as low-calorie, "light" foods with no or very little sugar or fat content. They were heavy on non-caloric sweeteners and fat substitutes or mimetics.

This third generation of health foods represents a distinct change of direction for nutritionists and consumers. Nutritionists know, and consumers are beginning to grasp, that some dietary constituents may be links to disease prevention. This understanding is as yet tentative and confused, fed as it is largely by science journalists in the media and advertising by manufacturers touting their disease-preventive wares; for example, new foods and beverages enriched with soluble fiber, or with calcium, or with carotenes, or with microbial cultures, or with ω-3 fatty acids, or with herbal extracts, or with natural foods in which any of the preceding

components are in high concentrations. Dietitians and nutritionists are slowly developing a sound scientific body of data demonstrating mechanisms of disease prevention through diet.

Functional Foods: Prebiotics and Probiotics

Two terms deserve greater explanation because they have become prominent in any discussion of nutraceuticals:

1. Prebiotics are non-nutritive components in foods that have an activity which has a beneficial effect on an individual's health when consumed. Prebiotics are a hodgepodge of chemical entities that defy description and are found in fruits, vegetables, fish and animals, and herbs and spices. They are best simply referred to as the phytochemicals (except those found in animals).
2. Probiotics are defined by Salminen et al. (1999) as "viable microbial cultures that influence the health of the host by balancing the intestinal microflora and thus preventing and correcting the microbial dysfunctions." Probiotics are also foods (for example, yogurts) which contain live microorganisms, largely but not exclusively of the *Lactobacillus* spp., but also bifidobacteria (Hoover, 1993), enterococci, proprionibacteria, and some *Saccharomyces* spp. (Lee and Salminen, 1995; Knorr, 1998).

(Some authors make a clearer distinction between the prebiotics and phytochemicals. Phytochemicals differ from prebiotics both in their function in the diet and in the concentrations in which they are found in foods. Phytochemicals are found in much smaller concentrations in foods. This distinction will not be made here but readers should be aware of it.)

Current thinking suggests a strong complementary activity between prebiotics and probiotics. Prebiotics include the various dietary fibers and oligosaccharides. They are either acted upon by the gut microflora, or they stimulate the gut microflora positively in some manner, or these food components are necessary to maintain the gut microflora in a healthy and functioning state (Katz, 1999). By this stimulatory action these prebiotics allow the gut microflora, the probiotics, to overgrow or compete successfully with any pathogenic bacteria or harmful material entering with the food.

Table 5.1 lists some biologically active non-nutrients with their sources (see Caragay, 1992; Tyler, 1993; Ramarathnan and Osawa, 1996; Kardinaal et al., 1997; Garcia, 1998; Katz, 1998; Ohshima, 1998; Anon., 1998d; Sanders, 1999; and Zind, 1998, 1999; for a more complete listing and review). Many of these, the saponins and lignans, in particular, are as yet poorly characterized structurally.

Table 5.1 Some Biologically Active Non-Nutrient Factors Determined to or Believed to have Beneficial Effects against Some Disease Conditions when Consumed

Classification	*Category and Food Sources*
Probiotics	Bifidobacteria • Fermented milks, yogurt *Lactobacillus* species • Fermented milks (acidophilus milk); yogurts *Streptococcus* species • Fermented milks, yogurts
Prebiotics (phytochemicals)	Fatty acids • α-linoleic acid (canola and flaxseed oils) • Conjugated linoleic acid (safflower, sunflower, and soybean oils) • γ-linoleic acid (evening primrose oil) • ω-3 fatty acids (various unsaturated oils) Lecithins • Phospholipids (various oils, especially soybean oil), e.g., phosphatidyl serine, phosphatidyl choline Unsaponifiables of oils • Phytosterols (canola and soybean oils) • γ-oryzanol and ferulic acid (rice bran oil) Organosulfur compounds especially plants of the cruciferous (broccoli, cabbage, and cauliflower) and allium (garlic, onion, and leek) families • Isothiocyanates (mustard oils of Cruciferous vegetables) • Sulfides (e.g., diallyl disulfide) and oxides (allicin) from garlic and onions Terpenes • Monoterpenes: limonene, perillyl alcohol • Tetraterpenes: lycopene, β-carotene

Table 5.1 (Continued) Some Biologically Active Non-Nutrient Factors Determined to or Believed to have Beneficial Effects against Some Disease Conditions when Consumed

Classification	*Category and Food Sources*
	Polyphenols (including flavonoids and catechins) • Anthocyanins (blueberries, cranberries, tomatoes, red wine, tea, onions, kale) • Various other phenolic compounds Phytoestrogens (isoflavones) • Genistein, daidzein (soybeans, whole grains, berries, flaxseed, licorice) Fiber (and associated material) β-glucans (oats, barley, wheat, rice) • Lignans (flax) • Other soluble and insoluble fibers (fructooligosaccharides, e.g., inulin in Jerusalem artichoke) Saponins (derivatives of pentacyclic triterpenes) • Ginseng, soybeans, grains Herbal components • See, for example, Tyler, 1993; Anon., 1998d

Prebiotics

After the discovery of fiber's health-promoting properties, the search for other non-nutrients with health giving properties was on. Literally and figuratively the floodgates burst. The number of prebiotics with suspected health-enhancing properties grew rapidly and is still rapidly growing.

That chemicals found in plants have a significant effect on the human body should not have been a surprise. Plants have been used for ages by many cultures for medicinal purposes; this is a well-established observation. Drug and chemical companies have scoured ancient medical writings, old herbals, folk literature for herbal traditions, and native peoples' herbal medicine practices and healing arts for clues to the plants used as medicines. From these sources they trace the herbs in hopes of extracting and identifying the beneficial phytochemicals. They will then

use them as raw materials to adapt as medicines, as food ingredients, or as initial building blocks for industrial materials.

Phytochemicals comprise a diffuse group including some micronutrients and a motley variety of chemicals with medical, stimulatory, flavoring, coloring, texturizing, antioxidant, non-caloric sweetening, narcotic, etc. properties. Some of the phytochemicals whetting the interests of food scientists and food manufacturers alike are (see also, Zind, 1998):

- Antioxidants. Vitamins C and E long known for their antioxidant properties have been used as such in foods. Both are reported to have a positive effect on the immune system and as well there have been reports of beneficial effects against cancer and cataracts (Elliott, 1999).
- Tocotrienols and γ-oryzanol. Both are sterols which are found in rice bran oil. γ-oryzanol is claimed to reduce plasma cholesterol, lower cholesterol absorption from the gut, and inhibit platelet aggregation (McCaskill and Zhang, 1999). The tocotrienols, similar to the tocopherols, are good antioxidants and also reduce cholesterol.
- Lycopene and carotene. The carotenoids are found in a variety of plant sources (Nguyen and Schwartz, 1999) but are especially plentiful in a common source, tomatoes. Carotenoids have been linked to a reduced incidence of cancer, particularly cancers of the prostate gland, lung, and stomach (Astorg, 1997). β-carotene also has antioxidant properties.
- Isoflavones. Genistein and daizein are proteins possessing estrogen-like properties which appear to inhibit cancer growth by stopping angiogenesis.
- ω-3 fatty acids which are found in the fats and oils of plant sources and also many animal sources (Ahmad, 1998). Some important fatty acids of this type and the related ω-6 type are palmitoleic, oleic, linoleic, and arachidonic. They play an important role in reducing the incidence of atherosclerosis and certain cancers.

Food manufacturers are eager to incorporate these into their food products and so promote the health benefits of their products.

Prebiotics are foods themselves or components of foods such as pea flour, sweet lupin meal, β-glucan, inulin, and other oligosaccharides especially those found in soybeans that have been used for centuries in many food products by the Chinese and Japanese (Katz, 1999). Petesch and Sumiyoshi (1999) report extensively on a conference on the nutritional benefits of garlic. Block (1985) had earlier written on the chemistry of garlic and onions and provided some explanation for their medicinal properties.

Confounding this presumed value of the prebiotics in the diet, there is controversy over their effectiveness. For example, there is contradictory evidence from epidemiological studies that suggests fiber does not have the protective effect against colorectal cancer as claimed. Fuchs et al. (1999) in a study of 88,757 women between 34 and 59 years of age conducted over a 16-year period could not produce evidence of any protective effect of dietary fiber against colorectal cancers or adenomas. So even with the nutraceuticals there is confusion about their benefits in the diet.

Probiotics

The activity of added microorganisms, the probiotics, in the gut produces a beneficial effect on the health of the individual. The ways in which this benefit is derived are slowly beginning to be elucidated. The addition of probiotics to the diet can be done with fermented foods as the vehicle or with either live or dead cultures directly. Live microorganisms have been used in foods for some preservative action that they offer for many centuries and by many cultures (Fuller, 1994; Knorr, 1998), for example:

- Alteration or removal of a sensitive, unstable substrate in a food, e.g., desugaring of egg whites or winemaking
- Acidification of the food to pH ranges inimical to food spoilage microorganisms, fermented vegetables (sauerkraut, various types of kimchi, bean curds, tempe) and fermented meat products (various sausages)
- Production of some protective antimicrobial agents by the added microorganisms which when ingested provide protection against microorganisms of public health significance
- The addition of beneficial (and benign) microorganisms to overgrow potentially hostile microorganisms originating in the food

Yogurt and cultured milk products, without too much stretch of the imagination, fit all the above. Microorganisms are introduced as starter cultures in meat or dairy products or they are present naturally in a food and selected through salting procedures, i.e., sauerkraut manufacture or other fermentation processes. Kimchi has been touted as a functional food with both probiotic and prebiotic characteristics (Ryu and West, 2000). Speck et al. (1993) describe the use of *L. reuteri* in acidophilus milk and products such as Sweet Acidophilus™ and BRA milk (*Bifidobacter* species, *L. reuteri*, and *L. acidophilus*) sold in Sweden. Knorr (1998) provides a lengthy list of products and their associated microorganisms.

Sanders (1999) reviews current thinking on the action and mechanisms of probiotics in the body. In addition, she lists strains of microorganisms with the reputed biological activity and diseases that they are believed to repress.

Brassart and Schiffrin (1997) discuss mechanisms for the beneficial action of probiotics and describe the possibility of designing products not only for healthy consumers but for clinical trials with sick people. They discuss both probiotic concepts of treatment using live micro-organisms and prebiotic concepts for treatment in which substrates (for example, oligosaccharides) on which the microorganisms feed are themselves fed to patients. Ishibashi and Shimamura (1993) describe the extensive applied research and product development that have occurred in Japan since the middle of the last century. Japan has been much quicker to adopt bifidus products (those utilizing Bifidobacteria) than have other countries.

Many areas of research for both prebiotic and probiotic components of foods remain to be explored further before effective new products can be developed for consumers in the new millennium to complement the enormous number of traditional fermented vegetable, meat, and dairy products that are available. Where, and at what site, in the gut are probiotics (and prebiotics) most effective? How can clinical trials using selected probiotics be undertaken (Brassart and Schiffrin, 1997)? Lee and Salminen (1995) discuss the need for more research to enhance the stability of probiotics and to define optimum concentrations for both traditional and new food products. These issues require answers before commercial advantage can be taken of prebiotics and probiotics.

Functional Foods: The Nutraceuticals

There is some dispute over the proper name for these factors. Many prefer that the term functional food be limited to foods containing prebiotics or probiotics, that is, be applied only to foods providing a health benefit. Nevertheless, nutraceuticals is the popular term in vogue; one used by many scientists themselves and is much more picturesquely descriptive of their value in nutrition.

In Table 5.2 some of the effects of pre- and probiotics are listed with proposed mechanisms of action. Because many prebiotics are strong antioxidants, it is believed that this property contributes to their biological activity. However, the simple and uninformative statement "boosts the immune system" begs the question, "How did the nutraceutical boost or stimulate the body's immune system?" Caragay (1992) describes one schematic for explaining some of the benefits of phytochemicals.

A growing interest in alternative medicine, that is, the use of herbal preparations used in folk medicines, has spurred the development of

Table 5.2 Suggested Modes of Action of the Prebiotics and Probiotics

Probiotics	*Prebiotics*
• Overgrowth of pathogenic bacteria in the gut by benign bacteria • Detoxification of toxic or carcinogenic factors in the intestinal tract • Hydrolysis of lactose • Stimulation of immune system • Antihypertensive effect	• Provide factors for or stimulate growth of probiotics • Tumor suppressors • Act as antioxidants to remove toxic free radicals • Stimulation of the immune system • Block or delay progression of cell growth and precancerous lesions • Improve circulation • Have an antibiotic action against pathogenic microoganisms • Influence cognitive function • Reduce cholesterol

non-prescription medicines, food supplements, and herb-based ingredients to be used in or on foods as well as new products. There has been a frenzy of research activity to find and identify the active components, the phytochemicals in herbals and foods, that have the promised benefits. When these have been identified:

- Isolated fractions containing the active components can be used as medicines.
- Their presence in foods can be enhanced through conventional or unconventional breeding techniques, for example, carrots with more carotene (Zind, 1998).
- Concentrates of isolated fractions can be used as ingredients to make finished foods.

At present, research is directed at developing methodologies for detecting and quantitatively analyzing their presence in foods. It is imperative that accurate methods be developed in order that:

- A dose/response correlation can be made.
- The action mechanism in the body can be understood. A major question still very much open is where, and in what form, do the prebiotics go in the body to produce the effects they have?

Challenges for the New Nutrition

As Young (1996) has put it

> *"The science of nutrition has moved…to understanding the physiological and genetic mechanisms by which the diet and individual food components influence health and disease."*

This new nutrition opens up a Pandora's box of ills and hopes. There are now opportunities to develop food products directed to specific health problems as, for example, anticarcinogenic foods or foods to improve cognitive ability or for use in particularly stressful situations such as occur in space flight, training for athletics, or in convalescence from trauma or surgery. There are already, for example, sports drinks, i.e., drinks designed to rehydrate the body rapidly or to provide energy or enhance energy metabolism during strenuous activity (Brouns and Kovacs, 1997).

But problems have arisen and will continue to arise for both food manufacturers and for legislators with these new opportunities.

Problems Presented by Functional Foods for Manufacturers

There has been a mad rush to capitalize on the consumer's quest for a long and healthy life free from debilitating diseases. It is obvious that interest in food factors that contribute to the prevention of disease, repair damaged DNA, have a hormonal regulatory effect, and enhance the body's immune system would have excited the scientific community and of food manufacturers.

The popularity of biologically active non-nutrients as subjects at scientific, technical, and trade conferences and exhibitions is immense. In the period from January 1998 to December 1999 there were more than 22 major events in 10 countries representing every continent except Africa and South America. These meetings were devoted to some aspect of nutraceuticals and functional foods as anticarcinogens, as marketing tools, or as food ingredients. They had titles such as:

> Functional Foods: Beyond Vitamins and Minerals
> Global Developments and Opportunities in Functional Foods and Nutraceuticals
> Herbal Extractions as Food Ingredients, Medicines, and Supplements
> Chemical and Biological Aspects of Dietary Anticarcinogens

This unscientific sampling of meetings excludes minor conferences and courses and omits generic food conferences such as those sponsored by

professional food, trade, or international associations whose conferences may have had individual sessions on functional foods.

The motivations of both scientists and manufacturers, however, may be vastly different. Scientists want eventually to identify and isolate those phytochemicals in foods having the beneficial effects of providing a long and healthy life.

The individual manufacturer is caught in a difficult situation. On the one hand there is an opportunity to develop new products with unique health benefits. At the same time, unfortunately, these phytochemicals already have the attention of customers/consumers and competing food manufacturers. The health(y) foods bandwagon is a popular one that all manufacturers want to be on.

On the other hand, unfortunately for food manufacturers, many of the promises the new products offer have not been clearly established; their safety for all populations has not been determined; and new product development costs money.

Manufacturers want to be able to inform their customers/consumers of the benefits of their products. Yet labeling and advertising regulations must protect customers/consumers from the hyperbole that often accompanies advertising claims. Some examples of announcements, taken from the Institute of Food Technologists Web site in the early months of 2000, are

> "add more than value to your food and beverages…add life, with Polyphenols" to describe products put out by Templar Food Products
>
> "…herbally-active, protein enriched frozen juice bars" which contained chromium, manganese, 100% of the daily requirements of Vitamins A, C, and E, as well as protein. These products were from Cold Fusion Foods.

With the rise in availability of these products also came a warning from the health professionals of the dangers some nutraceuticals might pose for people, especially people on medications and young children eating nutraceutified candies and snacks.

Manufacturers face the problem of trying to inform the public of the benefits of a new product in a product area where, metaphorically, shifting sands prevent the establishment of a firm product identity.

Both scientists and manufacturers work, or should work, hand-in-glove. Without tasty and desirable products developed by manufacturers, the health-giving components identified by the scientists would not be delivered to the consumer.

Delivery Systems

Delivery systems of phytochemicals have taken many forms. One candy manufacturer was adding phytochemicals which were purported to prevent cancer, bolster the immune system, and reduce cholesterol in the candies it manufactured (Zind, 1998).

Ice cream has become a vehicle for supplementation. It has been flavored with green tea (a source of catechins), ginger, avocado, sesame, wasabi, and capsaicins (hot pepper principle) to become a nutraceutical. Fiber and calcium compounds have been added to beverages.

The lowly potato chip and other snack foods, such as corn puffs, have had herbals and plant extracts such as ginseng, St. John's wort, ginkgo biloba, or kavakava added to them (Abu-nasr, 1998). The promotional gimmick would be that they would promote long life (ginseng); improve memory (ginkgo biloba); combat depression (St John's wort), and aid relaxation (kavakava).

These products and others with added chemicals join a growing list of products with added calcium to enhance calcium intake, with added caffeine to combat drowsiness, with creatinine as an aid for body builders, with added fiber to assist in lowering cholesterol, and so on. The marketing gimmick is to provide old products with a new role by giving them a functionality. By providing soft drinks with calcium, protein, or vitamins, they have been moved from a refreshment role to a functional one as a nutrified beverage; snacks with either St. John's wort or kavakava are given a medicinal role.

Manufacturers need to convince customers/consumers of the benefits — and justify the extra cost — of the enriched products. That is, they will have to develop effective means to communicate the health benefits to a frequently skeptical and jaded public about medical claims or health properties of foods.

Problems for Food Legislators

For legislators, the problems will be twofold:

1. Safety. First and foremost, the safety of the specific phytochemical in the concentrations used in a food must be clearly established. Like any other additive, ingredient, or medication, safe limits for all members of the public need to be established.

2. Regulation. Standards for health statements or claims must be promulgated in a manner fair and truthful to both manufacturers and customers/consumers.

Safety

Safety concerns are paramount. Phytochemicals are biologically active materials. Usage levels in prepared foods at concentrations higher than naturally found in a source food may not be safe for all populations. The presence of phytochemicals in common non-source foods, i.e., foods in which phytochemicals are not normally found but into which they have been added as an enhancement, may be harmful to some populations who eat a lot of the enhanced foods. For example, snack foods targeted for children or teenagers who are voracious snack food consumers may not be appropriate vehicles for supplementation with phytochemicals.

Chung et al. (1998), Kardinaal et al. (1997), and Hasler (1998) all have expressed a need for further research on the safety of functional foods in which the phytochemicals are found. Their concerns are many:

- How these phytochemicals work in the body is not clearly understood. What are the side effects?
- How nutrients in the rest of the diet might influence the activity of these phytochemicals or be influenced by them is unknown.
- There are no toxicity data on these substances. At best, there is only anecdotal information. Therefore there is no information on what acceptable dose levels might be for different segments of the population.
- There is also a danger of physiological interactions of phytochemicals with other medications that consumers might be taking at the same time.

Hasler, in particular, sees the need to balance benefits and risks with the use of foods containing physiologically active substances.

Chung et al. (1998), for example, review one phytochemical group, the tannins. These display rather ambiguous properties. On the negative side, tannins have hepatotoxic activity. They also display antinutritional activity since they can form complexes with digestive enzymes and proteins. The nutrient value of food is thereby reduced. Epidemiological studies have demonstrated high levels of mouth, throat, and oesophageal cancers in people using betel nuts, or the herb tea called *maíe*, and who use sorghum as a staple in their diets. All these products are rich in tannins. Chung et al. also report on a study in which a positive relationship has been noted between the incidence of tea drinking and that of stomach, lung, and kidney cancers.

On the positive side, these authors also report on studies that demonstrate that the tannins have antimutagenic, anticarcinogenic, and antimicrobial activity including some antiviral activity. In the case of the

ambiguous effects of the tannins, Chung et al. (1998) suggested that the effectiveness of the tannins for health promotion might be dose-specific.

Such dose specificity presents legislators with a dilemma because there are good and bad sides. There is a confusing array of promises and denials that will accompany any research into food components with biological activity to be used as viable adjuncts to the diet. Much more research must be done to clarify the value, or the danger, not only of the tannins but of many other phytochemicals.

Herbs and herbal preparations present a slightly different situation. Here a different cautionary note must be sounded. These preparations do have a long, substantiated history in folklore as cures for some maladies and, indeed, herbs have been the basis for many modern medicines. Many of their active chemicals have been rigorously studied by scientists. They have through this history developed a veneer of respectability. Herbs are readily available in most health food stores as well as mainstream supermarkets where they are sold as preparations for teas or tisanes.

Tyler (1993) and others have suggested several dangers respecting the sale of herbs and herbal preparations:

- Are they what they are claimed to be? That is, do labeled packages actually contain the herbs they are labeled with? Not all parts of herbs are effective; that is, roots, leaves, seeds, stems, flowers, bark, etc. may contain no or high concentrations of the phytochemical. Many countries do not have any regulations for the verity of herbal preparations.
- Herbal preparations are not standardized with respect to the active ingredient(s) that they contain. Do they contain the active phytochemical in the concentration claimed and are they safe concentrations?

When such unstandardized products are used as ingredients in food products the question then arises: Are they safe for all segments of the population?

Tyler (1993) does not give all the herbals a clean bill of health. Ginseng has a very low level of risk even with excessive use. St John's Wort also is relatively safe but may with some people and at high dose levels cause a photosensitivity. Ginkgo biloba extracts do promote vasodilation with improved blood flow but very large doses can have unpleasant side effects.

At the present state of nutritional awareness possessed by the general public and their obsessive desire for a quick cure for diseases which ravage them, consumers are vulnerable to exaggerated advertising. Women, for example, who know they are likely candidates for breast cancer might be swayed by genistein- or high-carotene-containing products. On the other hand, there is the eagerness of manufacturers to

capitalize on "being the firstest with the mostest" with products to capture a market niche. How safe are these products for consumers and who is to judge the suitability of these products for consumers concerned about their health?

Scientists, who stand to benefit from the financial support of the food industry, and the food industry, which stands to benefit from the findings of scientists, need to find some means to communicate their findings and promote products based on these findings. Neither wants to disseminate misinformation to or endanger the health of customers and consumers.

Such knowledge as this new science of nutrition is bringing into the hands of entrepreneurially spirited hucksters and promoters has spawned a host of new food products. The U.S. government has relaxed restrictions on food manufacturers' health claims. Already warnings have appeared from the medical profession and scientists about the overuse of products containing nutraceuticals especially in conjunction with conventional drug therapy.

Regulation

It would be only natural that if a food substance had a proven, or even a highly suspected, role in combating a disease condition or in preventing its occurrence or was able to combat memory loss or depression, that there would be a strong motivation for the consuming public to want the food containing that substance. This need by customers/consumers would be sufficient cause for food manufacturers to produce attractive and tasty products with that particular component in them. And it would be equally desirable to want to tell customers and consumers alike that this beneficial substance was in the product.

Proper regulation can only come when safety data applicable for all populations of consumers and good analytical procedures are in place, and uniform standards for products have been developed.

Genetics and Nutrition

> *"Tell me what you eat, and I will tell you what you are."*
>
> A. Brillat-Savarin, *Physiologie du Goût* (1825)

Nutritionists, at the close of the second millennium, were well aware that "one shoe didn't fit all" respecting the body's nutritional requirements. That is, a single set of nutritional guidelines could not adequately meet the needs of all members of the population in all possible physiological

states under all environmental conditions and all levels of activity. Earlier concerns were with the nutritional problems associated with undernutrition for which nutritional guidelines then in place worked reasonably well. They were not appropriate for nutritional problems associated with over-nutrition or the prevention or combating of chronic diseases. Thus guidelines had to be described for:

- Age of the consumer. Growing children obviously have more demanding needs as their bodies develop. Similarly, the nutritional needs of the elderly differ from those of young, vigorous adults and teenagers.
- Physiological condition of the body. Pregnant women, lactating mothers, and convalescing patients have more critical nutritional requirements.
- Geography and climate. People in tropical climates do not require the same caloric density of food as those living in arctic conditions.
- Activity levels. The heavy laborer, the athlete in training, the sedentary desk worker, the pressured, harried executive, the soldier on stressful military duty all have very different nutritional needs.
- Body composition. An individual's sex, body size, and weight also contribute to the nutritional needs of the individual.

These were all well-documented factors in establishing nutritional guidelines in the twentieth century. But even these were not enough.

Closer examination of feeding trials by nutritionists began to detect familial traits which led directly to the probability of genetic factors in nutrition. Why did heart disease run in families? Or overweight? Or high cholesterol? Or diabetes? Why, for example, would oat bran bring about a reduction in cholesterol in some people but not in others (Simopoulos, 1997)? Clearly, there was some other factor, perhaps a genetic contribution.

An interesting and statistically significant correlation was noted between the genetic taste marker, 6-*n*-propylthiouracil, and a preference for cruciferous vegetables and green and raw vegetables. People can be classified according to their ability to taste this marker: Some cannot taste it; some can taste it a little (medium tasters); and some react violently to the taste (strong tasters). Drewnowski et al. (2000) tested women with and without breast cancer. Those who were medium or strong tasters of the genetic marker disliked the vegetables most. They were less likely to have eaten cruciferous vegetables which have anticarcinogenic phytochemicals. There is an intriguing relationship here that requires further investigation. Duffy and Bartoshuk (2000), using the same genetic taste marker, reported in a small sample of women that a woman's liking for sweet and high fat

foods declined as her taste perception of 6-*n*-propylthiouracil increased. No similar observation was noted in men.

Phenylketonuria has been known for many years. This is a genetic disorder in which those afflicted cannot assimilate the amino acid phenylalanine. Cystic fibrosis is also a genetic disorder. It has long been recognized that individuals with cystic fibrosis are fat malabsorbers. Now research conducted by Alvarez and Freedman on mice genetically altered to have cystic fibrosis has shown that the fatty acid docosahexaenoic acid reversed these symptoms in mice (Maugh II, 1999; see also, the Cystic Fibrosis Foundation's Web site http://www.cff.org/news9910a.htm). This was reported at the North American Cystic Fibrosis Conference in Seattle on October 9th, 1999.

The past 20 or so years has seen a growing awareness of genetic variation and dietary interaction in the treatment of many chronic diseases. The result has been a marriage of the sciences of medicine, nutrition, and genetics with food science to develop pleasing and acceptable quality products to meet dietary needs. Some of the conditions listed by Simopoulos are detailed in Table 5.3.

Table 5.3 Chronic Conditions with Genetic and/or Nutritional Linkage

Chronic Condition
• Coronary arterial diseases
• Serum cholesterol levels
• Obesity: affected by hunger mechanisms, satiety, or body metabolism
• Diabetes
• Blood pressure
• Lactose intolerance
• Some cancers (breast cancer) with familial traits

An individual's genetic make-up can be a determinant (Simopoulos, 1997):

- In nutrient absorption
- In metabolism and the excretion of metabolic byproducts
- In taste perception and hence food preferences
- In the degree of satiation

All these genetic determinants greatly influence an individual's perception of foods, his/her metabolic reaction to foods, what is eaten, and how much is eaten. When these are life style factors (what Simopoulos calls

environmental risk factors), then there is a clearer picture of how diet and genetic make-up can influence a person's health.

Obesity can have a genetic basis but as Foreyt and Poston (1997) point out, obesity is "… a multifactorial disorder with multiple causes." They report that at least 20 genes might be factors in some types of obesity. Environmental factors (for example, level of activity) do play a strong role in obesity as well.

In the third millennium consumers, from childhood to mature adulthood, will be assessed for what diet is best for them based on their genetic make-up. The technology will be available to prescribe diets for individuals based on foods containing all the correct factors to reduce the risk of diseases that their familial history and genetic make-up indicate they might be subject to (Patterson et al. 1999). By understanding the molecular mechanisms in health and disease, diseases can be subdivided more specifically and treated accordingly with a more directed dietary intervention. Shades of George Orwell's Big Brother watching one!!! Instead of the Thought Police described in Orwell's *1984* it just might be the Diet Police who are watching.

Incorporating the findings of genetics into nutritional guidelines for consumers and, at the same time, developing nutritionally suitable, quality food products that are appealing in taste and texture will present major technical, communication, and logistical problems. It creates, as Dodd (1997) puts it, the personalization of dietary guidance.

Medical Foods

The previous topic leads directly to the subject of medical foods. These are designer foods of a unique nature. They are nutritionally controlled foods intended for hospitalized patients suffering severe trauma who must be fed either intravenously or by a nasogastric tube or for individuals who for a variety of reasons may require special diets. Some reasons described by Schmidl and Labuza (1992) for the need for medical foods are presented in Table 5.4.

Schmidl and Labuza (1992) classify these foods into four distinct groupings:

1. Nutritionally complete products which provide all the required macro- and micronutrients for individuals
2. Nutritionally incomplete products which provide either a single nutrient or a combination of nutrients to supplement the individual's intake

Table 5.4 Conditions for which Nutritionally Designed Foods may be Required

Conditions Requiring Nutritionally Designed Foods
• Severe trauma resulting from physical injury, cancer irradiation therapy, burns, etc.
• Malabsorption of nutrients resulting from intestinal resection or disease
• Gastrointestinal organ malfunctions
• Severe allergies requiring avoidance of or very controlled amounts of nutrients
• Genetic errors of metabolism
• Physical state of the individual, i.e., immobility

3. Foods for metabolic disorders which are designed to provide the nutrients required while minimizing the adverse effects of the nutrients responsible for the disorder
4. Oral rehydration solutions which are designed to replace water and electrolytes lost in some diseases

The actual composition of these diets will vary widely with the particular disabilities of the individual. Schmidl and Labuza provide an extensive listing of some ingredients used in their preparation.

Salminen et al. (1999) give information on the use of probiotics to alleviate the symptoms of lactose intolerance and some diarrheas. Duran et al. (1999) report on the importance of the management of blood phenylalanine levels with a phenylalanine-free amino acid mixture. Their sample comprised patients hospitalized because of careless personal home treatment.

As organ transplant operations become more common, there will inevitably be nutritional complications for recipients, especially those receiving liver, kidney, and intestinal transplants. Silver and Castellanos (2000) discuss a case study involving the nutritional management of an intestinal transplant in a child.

The last two references introduce interesting challenges. Organ recipients as well as those with genetic metabolic disorders will require medical foods with uniquely designed nutritional requirements but which must also be appealing taste-wise, visually, texturally, and are safe from a microbiological and toxicological standpoint. There is an excellent opportunity for food technologists, dieticians, and the medical profession to

create such desirable products for victims of genetic and chronic diseases, or suffering radical surgery to control or alleviate their infirmities.

The Quest for A Long and Healthy Life

There is a natural desire on the part of the general public to want to live a long and healthy life free of chronic diseases. Some consumers will try, within certain limits, to adopt foods or activities that promote such a healthy life. The vicissitudes to one's length of life and to one's general well-being brought on, for example, by obesity or overweight, have brought out a number of countermeasures which many have adopted with more or less success:

- Physical activity. By becoming more active people can hope to keep their weight down and their physical well-being improved.
- Better nutrition through better diets. Adherence to recommended dietary guidelines plus information from low fat cookbooks and books describing better health through special diets all prompt people to watch their diets. Restaurants now promote low fat dishes or vegetarian items on their menus.
- Lifestyle changes. Attempts have been made to change lifestyles Thus was born the Western embracing of ancient Asian and oriental philosophies. These were not new philosophies but were new to most in the Western world. Their practice brings calmness and spirituality to the individual and is an aid to meditation.

Unfortunately many of the diets that are promoted in the diet cookbooks are written by non-professionals or by authors with questionable motives in writing them. They have some gimmick or personal theories they wish to promote. These cookbooks are best described as containing fad diets.

Physical activity became a panacea for many ailments afflicting the body. Running, tennis, swimming, hiking, aerobics classes, gymnastic dancing, stationary bicycles, stepping stairs, and treadmills all became vehicles to burn calories, condition the heart, lower cholesterol, and combat the onset of osteoporosis. All this was in the name of a healthy and productive life well into old age.

Prudent menu choices, items having low fat or low salt or no cholesterol (e.g., cholesterol-free eggs for breakfast), have been indicated on restaurant menus for the past 30 years or so. While at that time the major health concerns were cholesterol and saturated animal fats, now the properties of fats high in mono-unsaturated fatty acids are ballyhooed

as being as important in good nutrition as are those fats rich in ω-3 fatty acids.

Changing lifestyles of individuals is difficult. Outside intervention as well as the personal commitment of the individual are required to manage such a change. Nonetheless, people, some 30 years ago, were answering questionnaires to determine if they were type A or type B personalities. Type A personalities were characteristic of those individuals who were aggressive and driven, in effect, workaholics, and were thought to be potential victims for a heart attack because they could not control their stress and anxiety levels. Type B traits were marked by more complacent, calm, serene and relaxed attitudes. People with these Type B traits were considered less likely to have heart attacks.

Toops (1999) extravagantly headlined an item describing philosophical movements as food spiritualism and in support of her assertion described a series of Zen-themed cookbooks. Classes, associations (variously described as spiritual wellness centers), even political parties (the Natural Law party, for one) associated with these philosophies have sprung up. As adherents to these philosophies grow in number, food manufacturers should look carefully to take advantage of these trends not only with food products but with the paraphernalia associated with their practice.

For those embracing these philosophies to change their lifestyles and to improve their health, there were myriad secondary and even tertiary demands in addition to meditation. Many of these philosophies are also associated with certain ritual activities and exercises such as yoga, tai chi, etc. The practice of these exercises and teachings was considered to aid the individual in controlling stress, lowering the blood pressure, and helping the individual to live longer. Particular foods and diets associated with the cultures that embraced these philosophies, faiths, and religions were recognized and popularized by food manufacturers and restaurants.

In some small measure these philosophies, plus the general concern for less fat in the diet, have spurred an interest in vegetarian cuisine or certainly in a cuisine less dependent on animal protein as a major component in the diet (Wrick et al., 1993). (In developing countries, the interest is in adding some animal protein to their diets.) This, in its turn, has led to opportunities for food manufacturers for the development, promotion, and sales of new foods and new food products adopted from these philosophies as well as the publication of diet and recipe cookbooks based on them and adapted to Western society's culinary habits.

Thus there was, and will continue to be, an amalgamation of food (actually diet), philosophy, and physical activity. The new millennium will, no doubt, witness a greater acceptance of these philosophies and their dietary regimes. Alternative medicines as embodied by acupuncture and herbalism have also become popular.

Exploiting the Consumer's Quest

The exciting possibilities for functional foods in the control, amelioration, or slowing down of chronic and degenerative diseases will certainly pit two unlikely foes: food companies and pharmaceutical companies. The two will approach the issue from very different promotional aspects. For each it is a new venture. The pharmaceutical companies will venture into healthy, good-for-you foods while the food companies venture into medical foods, i.e., into patent medicine foods.

There are several terms to describe these new products: functional foods, designer foods, and medical foods, and they can take several forms:

- Dry for making teas and tisanes
- Beverages such as prepared flavored teas, tisanes, soy milks, nutriceutified juices
- Dairy products such as yogurts and fermented milks
- Snacks flavored with herbal preparations
- Supplements in the form of capsules, tablets, and liquids (patent medicines)
- Main dishes (soybean veggie burgers)

Wrick et al. 1993 conducted a telephone survey that showed older respondents were more aware of the health benefits of functional foods containing phytochemicals than were younger respondents. This older group was also more likely to believe in the efficacy of these products. Wrick et al.'s study also indicated that the preferred way to deliver these phytochemicals was by increasing the consumption of fruit, vegetable, and cereal products followed by the corollary suggestion to increase the content of these foods with phytochemicals by developing special varieties.

The least desired ways of delivering the beneficial ingredients were with pills or capsules, fortified snacks (cookies, candies and beverages), or additions to the water supply.

Some of the concerns that food manufacturers have about commercially exploiting these foods are discussed in depth by Kuhn (1998). These have been touched upon already:

- Safety of functional foods and phytochemicals
- Extracts or concentrates vs. the natural food
- The ethics, and safety of, fortifying snack foods targeted for children

Dietary Advice: Educating the Public

Toops, News and Trends Editor for *Food Processing*, wrote (Toops, 2000) in the lead article of the Leatherhead Food Research Association: "In three

months last year, almost 1,000 contradictory food and nutrition articles were reported." Such a statement staggers the imagination. Many public and high schools have removed nutrition from their curricula. Governments have removed financial support for health and physical activities and gone, too, are many school milk programs.

Nutritional knowledge is largely dispersed to the general public through various channels: cooking columns in newspapers, nutrition and diet columns in magazines, radio and television food shows, and now the Internet. It is here that the public learns that cardiovascular diseases, heart disease in particular, high blood pressure, certain cancers, diabetes, and several other diseases may be caused by poor nutrition. They learn that heavy consumption of alcohol can lead to cancer of the esophagus and of the liver and that a high fat diet can be implicated in breast, pancreatic, and some intestinal cancers. They also learn that one or two alcoholic drinks a day are good for one's health; red wine prevents macular degeneration, etc.

Consumers are also told that the advent of these disorders may be prevented, deterred, delayed, or somehow the odds of getting them may be reduced by good nutrition or even, and here is the rub, by the consumption of specific foods. For example, fiber from various sources has been described as beneficial for lowering cholesterol in the blood and as a preventive against some intestinal cancers. Vitamins A, C, and E are reported to reduce the incidence of some cancers. Indeed, vitamin E, as reviewed by Ahmad (1996) has a protective role:

- Against free radical formation in exercise and in the aging process
- In the development of heart disease
- In the maintenance of structure and function in the nervous system
- In cataract development
- In the proper functioning of the immune system
- In maintenance of the skin against the deleterious action of the sun
- In cancer prevention

Soybeans and products derived from them (genistein, for example) have been reported to reduce the risk of certain cancers.

That is what customers and consumers alike are being told. It is unfortunate that information, misinformation, and confusing information about nutrition can be also disseminated to the public by these very same media.

A practical example of the information available to consumers about one of these new obsessions, herbal preparations, is well depicted by an article in a national newspaper by Owens (1999). It clearly presents the dilemma faced by consumers of herbal preparations, by the scientists who study them, by science journalists who write in the popular press about them, and by manufacturers of herbal preparations and extracts.

First, there was a correct, but perhaps misleading, headline — misleading because of its brevity: "Herbs linked to fertility risk." The study was done on hamster sperm and eggs.

Then there followed the subhead: "Studies show high doses of herbs, including the popular echinacea, have an ill-effect on fertility in hamsters. But scientists say they don't know the effects on humans." Correct so far, but again there is no mention that this was an in vitro study.

The study (Ondrizek et al., 1999) was referenced in the article by Owens by journal and lead author. (In addition, the lead author was interviewed by Owens.) Ondrizek's team found that high doses of three herbs, echinacea, ginkgo biloba, and St. John's wort damaged reproductive cells and stopped sperm from fertilizing eggs of hamsters in in vitro studies. This later finding was duly reported in the article. Owens also reported in the article that Ondrizek admitted that the effect of these herbals on human fertility was unknown. A further disclosure was that St. John's wort resulted in DNA mutations. The leader of the team was reported to say that more studies, including human studies, were necessary.

(Parenthetically it should be reported that

- Echinacea has a well-substantiated reputation for its immune-stimulant properties.
- Ginkgo biloba extracts have a well-documented history of usefulness in treating conditions caused by a decreased cerebral blood flow (usually touted for help with short-term memory loss).
- St. John's wort has gained a respected reputation for usefulness in treating anxiety and depression.

The foregoing information for these herbs is from Tyler (1993), a respected and recognized authority on plant drugs.)

Manufacturers of herbal preparations were reported (by Owens) to cry "unfair". Owens interviewed one executive of the largest manufacturer of herbal preparations in Canada who stated that there was no cause for public concern but rather a need for more research studies. He claimed there was no evidence the ingredients in these herbal preparations ever reached the reproductive system (when taken orally).

What are consumers to think? The reporting was fair and thorough in presenting various sides of the issue of safety: Owens contacted the lead researcher, she contacted a spokesman for the Nonprescription Drug Manufacturers Association, and she interviewed a senior executive of a manufacturer of the preparations. Would most consumers have read and

understood the implications of the entire article? In particular, how will consumers react to snack products to which manufacturers are adding some herbal preparations?

The Internet, an increasing popular source of information, can, unfortunately, be both a rich source of reliable information and a repository of false and misleading information about nutrition. An Internet search for the phytochemical, oryzanol, provided many interesting and somewhat outrageous claims for the product's efficacy from suppliers.

Who is Responsible for "Responsible" Nutrition Education?

This is a question that seems to have fallen outside everyone's area of responsibility. Governments, i.e., those responsible for public education, seem to have no interest in subjects like nutrition, health, and physical activity, or at least, pay only lip service to these topics. As money for education gets tighter, these are the items that suffer most by deletion from the curriculum.

Governments do establish nutritional guidelines and attempt to educate with pamphlets and brochures. These are distributed throughout the school system.

Childs, reported by Busetti (1995), describes the news media, then the medical community, followed by government nutrition awareness campaigns as the major vehicles for the consumers' awareness of nutrition. Manufacturers' advertising was the poorest vehicle for conveying food health benefits to consumers.

The validity of these vehicles for education is highly variable. The media thrive on controversy and the "breaking story." The story must be told in 10-second sound bites. For accuracy in educating, television and radio are not good (the so-called infomercials now so common on television should be classed as manufacturer's advertising and not considered authoritative). Print media can do a more in-depth treatment but it is doubtful how well in-depth stories are understood by the general public despite competent reporting (see previous section). Again, reference must be made to Toops' statement about the frequency of contradictory nutritional stories (Toops, 2000).

The medical community and government resources then are the only reliable sources for nutritional information that the average consumer has.

Thompson (Count Rumfound) was astonished at the neglect given to the science of nutrition. He would be equally appalled at the lack of nutritional education provided to children and adolescents in primary and secondary schools to impart knowledge that would serve its recipients throughout their lives.