

# The science of nutrition -- the metaphysics of food

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With respect for the differences between and among nations, there are universal principles on which public health nutrition policy should be based. An adequate food supply containing sufficient energy and all of the essential nutrients should be available and affordable. This may include nutrient-restored or fortified food products and supplements. The foods must be coherent with the cultural needs and desires of consumers. Public and private agencies, like schools and food industries, must provide exciting and accurate nutritional information in the classroom and by mass media. Individuals must have an accurate knowledge to make healthy dietary selections. The special needs of particular sub-populations, such as prenatal mothers, infants, children, adolescents, women, and the elderly, should be emphasized and addressed. Individuals should be encouraged to assume personal responsibility for their health. The avoidance through healthy lifestyles of obesity, anorexia and nutritional deficiencies should be encouraged. The sensual pleasures of food and the joy of eating with family and friends should be emphasized and enhanced. We should celebrate the complexity and diversity of our foods and cultures. We should be free to enjoy the foods that bring us health and pleasure. We should have scientific nutritional knowledge to maximize our human potential.

## Optimal Diets

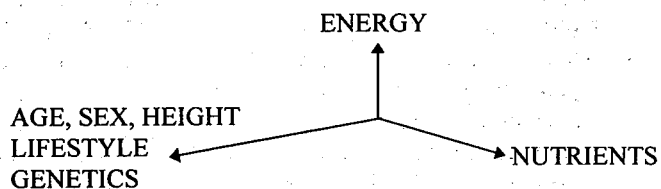
A medical breakthrough occurred almost thirty years ago when total parenteral nutrition (TPN) became a reality<sup>1</sup>. For the first time it was possible to sustain growth and development of human life by intravenous infusion in the absence of ingested food and water. A culmination of chemistry, biochemistry, physiology, nutrition and medicine, TPN is an aqueous suspension usually containing 44 essential chemical nutrients. They are:

- Water
- Energy sources- glucose, lecithin (phospholipids), triglycerides
- Minerals- potassium, sodium, calcium, magnesium, chloride, phosphate, sulphate
- Amino acids- leucine, isoleucine, valine, methionine, threonine, phenylalanine, tryptophan, lysine, arginine, histidine
- Vitamins- Fat soluble- A, E, D, K  
Water soluble- pyridoxal, riboflavin, nicotinate, thiamin, folate, pantothenate, B12, biotin, ascorbate
- Trace elements- iron, copper, zinc, manganese, chromium, molybdenum, nickel, selenium, iodine, fluorine, boron.

Thanks to scientific research, the structure and function of each nutrient in the TPN solution and how each is utilized by our body is understood.

But people can not live by TPN alone. Indeed, life would be less interesting were it not for the sensual joys of eating. Under ideal conditions we should obtain all of the essential nutrients from our foods. Thus, the nutritional challenge is to have access to and to consume a variety of foods that continually provide us, over any given span of three to five days, the optimal amount of energy and

nutrients appropriate for our age, sex, height, genetic inheritance and life style. Diet can be considered in terms of a "Three Dimensional" Nutritional Space:



There is an infinite number of optimal diets within the three-dimensional nutritional space, depending on the foods available and the pleasures derived from eating them<sup>2</sup>.

A recent trend in developed nations is to focus dietary attention with special reference to fat, cholesterol, salt and sugar on degenerative conditions found in older populations. Such diets may be less appropriate during the growth and development of infants and children. Nutritional policy and advice must pay attention to age. Efforts should be directed to optimizing human potential, especially during the early years.

The body can utilize essential nutrients independent of their source. There is no difference in a vitamin or a mineral obtained from a natural food, a fortified processed product, or a pharmaceutical supplement except its nutritional context. Sufficient variety of foods in adequate amounts can provide a healthy diet. When certain foods with specific nutrients, such as dairy products containing calcium, are unacceptable or unavailable, other more accessible foods can be considered for fortification. When

red meat and other effective sources of iron, copper and other trace elements are expensive, scarce or unacceptable, then fortification and supplementation can be prudently applied to other products.

Despite widespread beliefs to the contrary, there are no 'good' foods or 'bad' foods. There are 'good' diets and there are 'bad' diets. All foods have nutritional value. Millions of books are sold in the Western world promising 'perfect' diets for the prevention or cure of a myriad of diseases. Governments seek to legislate diet strategies for public health. There is no single 'health' diet that is universally acceptable or is possible to implement. The goal of any national dietary health program is to provide access to safe agricultural products of plant and animal origin, and to educate its citizens to make rational and pleasurable choices concerning their personal diets.

### Nutrients

Before we consider the metaphysical aspects of food, let us examine scientifically the nutritional chemical components of total parenteral nutrition. Foremost among the nutrients in both concentration and importance is water. This remarkable life-giving compound is essential as solvent, chemical reactant, buffer, thermal regulator, electrolyte and structural component. Its absence or insufficiency quickly leads to death. The source of the water, beverage or food in which it is ingested is of little matter. Only the volume consumed and its biological safety are important.

When technology was developed for the formulation of stable suspensions of phospholipids, it meant that enough energy could be infused to sustain life without disturbing electrolyte and water balance or causing obstruction of the capillaries. The energy requirement of the body is met with both glucose, a simple sugar, and fat as the phospholipid, lecithin. Approximately 35% of caloric energy is supplied by glucose and over 50% from fat. Glucose serves not only as a source of calories, but also as an essential chemical precursor to vital biochemical intermediates including other sugars, organic and amino acids, and nucleotides. Phospholipids not only have high caloric density, but also supply essential polyunsaturated fatty acids as precursors for the hormone-like prostaglandins and thromboxanes.

Seven major minerals are responsible for: the maintenance of electrolyte balance, enzyme cofactors, the function of excitable membranes, muscle contraction, the structural integrity of membranes, mineralization of bones and teeth, energy conservation and transfer, second messengers, etc.

Eight of the amino acids are essential in that humans have limited or no capacity for their synthesis. Arginine and histidine can be synthesized by the body, but not in optimal amounts for growth and development. All essential amino acids must be present simultaneously to ensure proper protein synthesis. The aromatic amino acids, tryptophan and phenylalanine, are precursors for important neurotransmitters and hormones.

Thirteen vitamins, four fat-soluble and nine water-soluble, have been isolated, characterized, synthesized and their biochemical and physiological mechanisms identified. There are no fundamental differences between "natural" and "synthetic" vitamins. All vitamins are small organic molecules that cannot be synthesized by the body. They are required in very small amounts and are metabolically

modified prior to or during their biochemical action. The fat-soluble vitamins serve as visual pigments, regulators for calcium metabolism, cell growth and differentiation, antioxidants, and coenzymes. With adequate exposure of the skin to ultra-violet light, the body can synthesize adequate vitamin D. The fundamental role of the water-soluble vitamins is to serve as dissociable coenzymes and prosthetic groups required by a majority of cellular enzymes. Most reactions including redox, group transfer, and energy conservation require such vitamin related cofactors.

Eleven trace elements comprise less than 0.01% of the weight of the human body. They are essential in a variety of ways: enzyme cofactors, redox reaction centers, oxygen transport, regulation of gene expression, thyroid hormone synthesis, and bone structure. Iron, copper and zinc deficiency are frequently observed in both economically developed and under-developed populations. The resulting anemia, impaired growth and development, and poor physical and mental performance constitute a serious public health concern. High concentrations of some trace elements can be toxic. Fortification of some staple foods can successfully address deficiency problems of iodine and iron.

Although TPN defines base nutritional needs, it is our diets that must provide these nutrients. This is the interface where science must harmonize with both the metaphysical personal and societal belief systems as well as economic, agricultural and political realities.

### Food choice and culture

For centuries in Chinese culture, nutritional medicine and culinary art were considered to be one<sup>3</sup>. Diet therapy and herbs were the foundations of Chinese medicine. Foods were classified as 'heating' or 'cooling' based on their apparent energy content, flavor, tactile texture, or color. The 'heating' foods were used to treat the effects of shock, chills, wasting and diarrhea, while 'cooling' foods were used to treat fever, constipation, and rashes. Meat provided strength. Vegetables could relieve symptoms now associated with vitamin deficiency. The treatment of the four 'humors' of the body—heat, cold, wetness and dryness—has a long history shared by the cultures of East and West. Certain foods were endowed with special strengthening properties, the power of pu. Wild fowl, sea cucumbers, and bird's nests for strength, walnut meats for the brain, jujube and red wine for anemic blood are but a few examples. Each, in scientific fact, may have been efficacious. Food as nutrient merges with herbs as medicament with the use of ginseng and herbal teas. Some foods are considered aphrodisiacs or sexual stimulants. Some foods are eaten with the belief that 'you are what you eat.' Thus the physical characteristics of deer, eagles, pangolins and other creatures could be transferred to the person who ingested their flesh. Lungs of various creatures were eaten to improve respiratory function. Blood was consumed to supplement anemia. Some foods were considered to cause diseases and were carefully avoided. The complexity and richness of Chinese cuisine are, in large measure, due to the pressures upon the people to utilize every available food source and to impart special benefits to its use.

The issues of food and culture in the United States have similarities and differences with those of China. The US has a comparatively young civilization, barely 300 years old. It is a melting pot of cultures including Asian, European, Native American, African, and Middle Eastern in which the diet reflects its ethnicity and history. It has evolved a fast food culture that includes such staples as Big Mac Hamburgers, Coney Island hot dogs, Kentucky Fried Chicken, French-fried potatoes, potato chips, Snickers candy bars, apple pies and Twinkies sweet cakes. Typical drinks include soft drinks such as Coke, Pepsi and diet colas, and milkshakes made from ice cream, milk, and flavoring.

The US has an eclectic culture that embraces food of all nationalities. World cuisine is prepared at home as well as served in restaurants. Chinese, Japanese, Korean, French, Italian, Scandinavian, Mexican, Caribbean, Arabic and African dishes are now an everyday part of American lives. The Chinese should embrace America's gastronomic contributions. There is much to enjoy. As people share and relish each other's ethnic cuisine, we also begin to share understanding and appreciation of each other's social and cultural heritage.

#### Overconsumption and deficiency

America produces an abundance and diversity of agricultural products including grains, nuts, fruits, vegetables, cooking oils, sugar, poultry, eggs, beef, milk, cheese, pork, lamb, and fish. It has the ability to produce, process and distribute food year-round at low cost, ready convenience, and high palatability. Over-abundance and over-consumption have become major public health problems. The nutritional curse of the economically advantaged nations has become obesity<sup>4</sup>.

Once again we confront the biological science of nutritional obesity (body weight or BMI greater than 20% of ideal) and the metaphysics of aesthetic obesity (the human body judged by self and others in the mind's eye of our psyche and culture). There is a close positive correlation of obesity with six major causes of mortality and morbidity: coronary heart disease, stroke, late onset diabetes, hypertension, some cancers, and gall bladder disease. Each of these conditions has a significant genetic component over which the individual has little or no control. Each is partly a function of aging. Each of the diseases is exacerbated by obesity.

The control of body weight is determined by the balance of energy intake from food with the energy output required for maintenance of basal metabolism plus exercise. Too frequently, weight loss is managed by overemphasis on stringent low calorie dietary restriction. Equally important is the increase of physical activity. Exercise is not only directly linked to higher energy use but also provides transitory increase in basal metabolic rate and a suppression of appetite.

It is widely believed that dietary fat and cholesterol are the sole causative agents for coronary heart disease, stroke and cancer. Further, it is held that animal fats containing saturated fatty acids are 'bad fats,' while vegetable oils with mono- and polyunsaturated fatty acids are 'good fats'. Whilst it has been recognized that populations and individuals may consume more without adverse cardiovascular or body fatness effects, it has been

recommended that diets should contain no more than 30% of calories from fat. This indicates that other dietary or lifestyle factors, such as physical activity along with genetic predisposition contribute to final health outcome. The French, for example, whose diets contain 45% of energy from fat have mortality rates from coronary heart disease about half those of the United States<sup>5</sup>. The prevalence of obesity in France is also about half that of the US. In the United States, despite reduction of fat consumption from 42% to 34%, the prevalence of obesity continues to rise<sup>6</sup>. The fundamental issue is energy balance. The French eat smaller portions of high fat food, do not snack between meals, and perform more physical exercise.

There is a real metabolic difference between fat and carbohydrates with respect to the storage of unburned energy. Excess carbohydrate must be converted to depot fat at an energetic cost of about 25% of the calories stored. Within the total balance of calories used and stored, this represents a trivial fraction. The real danger of fat in our diets is that fat makes food taste good, and thus we eat more-- we pay the thermodynamic price in obesity.

The effects of dietary cholesterol are often misunderstood<sup>7</sup>. Cholesterol is an integral part of every cell membrane. It is also the essential precursor to all steroid hormones. Cholesterol is synthesized in the liver from the two-carbon metabolic intermediate, acetyl-CoA, by a regulated pathway. When too many calories from carbohydrates, fats and amino acids are ingested, acetyl-CoA concentrations rise and both fatty acid and cholesterol synthesis increase as a function of mass action. Serum cholesterol correlates positively with obesity and coronary heart disease. Intrinsically, neither fat nor cholesterol is a dangerous nutrient. Both are essential metabolites synthesized by our cells.

The effects of dietary cholesterol on serum cholesterol are also dependant on coingestion of fat especially saturated fat. The serum distribution of cholesterol between high-density lipoprotein (HDL) and low-density lipoprotein (LDL) is a measure of susceptibility to coronary heart disease. The lower the ratio is of HDL/LDL the greater the risk. This ratio can be favorably shifted somewhat by increasing dietary polyunsaturated fats. Saturated fats in the diet increase the LDL. Meat, eggs and dairy products, good sources of iron, copper and other trace elements as well as calcium, high quality proteins and many vitamins, can be eaten with little impact on serum LDL cholesterol when low in saturated fat.

The most prevalent nutrient deficiency in the economically advantaged nations is for iron and, to some extent, copper, zinc and manganese<sup>8</sup>. For vitamins, folic acid status is often more marginal than appreciated. Iron and copper deficiencies lead to anemia and its attendant effects on physical and mental activity, and growth and/ or development. Copper, manganese and zinc deficiencies inhibit bone formation and contribute to osteoporosis. Calcium deficiency is also widespread as a consequence of the reduced consumption of dairy products. Most women, young and old, are consuming less than half their recommended daily allowance of calcium. It should come as no surprise that over 30% of postmenopausal women in the United States are afflicted with osteoporosis. It is however, becoming apparent that, in some food cultures lower calcium intakes may be possible for comprable bone

densities, depending on other food factors which are bone protective and on physical activity.

Prenatal and postpartum nutritional strategies are essential to promote optimal growth and development of infants<sup>9</sup>. The subsequent nutritional needs of children can focus on developing their understanding and responsibility concerning selection of their diets from within the three-dimensional nutritional space. Federal Government food policy has shifted from providing nutritional information and safe foods to promoting 'Diets for a Healthy America' with the goal of preventing some diseases. Particular attention was focused on school meal programs. Such policy is controversial. It assumes we can dictate a healthy diet and further assumes that the children will eat it.

The terms junk foods and health foods are generally unhelpful. Sugar, salt, fat, cholesterol and refined flour do provide nutrients. Fruits, vegetables, grains and unrefined sources of carbohydrate should be an integral part of

healthy diets as should meats, fish, poultry, eggs and dairy products. The focus of nutritional attention should be on weight management achieved by reducing energy intake and increasing exercise. A great deal of attention has been given to oxidative free-radicals as the causal agents in cancer, coronary heart disease, stroke and aging. The interest in prevention of oxidative stress by anti-oxidants has led to increased consumption of fruits and vegetables and the use of supplements containing mega-amounts of vitamin E, vitamin C, B-carotene and selenium. There have been some studies in China under conditions of dietary antioxidant deficiencies where such supplements prevented some forms of cancer<sup>10</sup>. However, similar studies in Finland, in the absence of prior deficiencies, found no added protection by supplements<sup>11</sup>. Scientific nutritional knowledge maximizes human potential for health and pleasure.

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## 营养科学与食物的抽象理论

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### 摘要:

营养学是一门自然科学, 但人们在选择食物时却受到形形色色超自然力量的支配。理想的是两者相辅相成, 构成一个协调的整体。世上没有绝对“好”的食物, 也没有绝对“差”的食物; 但世上既有“好”的膳食, 也有“差”的膳食。世上没有十全十美的膳食, 每个国家应使人民能获得安全的动植物产品以及教育人民选择合理和适合自己口味的食物。各国之间尽管有巨大差别, 但应可有制定营养政策的普遍适用原则。如, 应当充足地提供有足够热量和所有必需营养素的食物, 食物应符合文化需要和消费者的喜爱; 应通过学校和大众媒体提供准确的营养信息, 使人们有正确的知识来选择健康的膳食; 应重视特殊人群(孕妇、婴儿、儿童、老人等)的特殊营养需要; 加强自身保健意识, 不应对肥胖、厌食和营养乏置若罔闻, 以应重视食物所引起人们感觉上的愉快和与亲朋好友共同进餐的乐趣。

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