JOYFUL LIVING SERVICES

History of Nutrition

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Nutrients

There are seven major classes of nutrients: carbohydrates, fats, fiber, minerals, proteins, vitamins, and water. These nutrient classes can be generally grouped into the categories of macro nutrients (needed in relatively large amounts), and micro nutrients (needed in smaller quantities). The macro nutrients are carbohydrates, fats, fiber, proteins and water. The other nutrient classes are micro nutrients.

The macro nutrients (excluding fiber and water) provide energy, which is measured in kilocalories, often called "Calories" and written with a capital C to distinguish them from small calories. Carbohydrates and proteins provide four (4) Calories of energy per gram, while fats provide nine (9) Calories per gram. Vitamins, minerals, fiber, and water do not provide energy, but are necessary for other reasons.

Molecules of carbohydrates and fats consist of carbon, hydrogen, and oxygen atoms. Protein molecules contain nitrogen atoms in addition to carbon, hydrogen, and oxygen. The nitrogen-containing components of protein, called amino acids, fulfill many roles other than energy metabolism, and when they are used as fuel, getting rid of the nitrogen places a burden on the kidneys.

Other micro nutrients not categorized above include antioxidants, essential fatty acids, and phytochemicals.

Most foods contain a mix of some or all of the nutrient classes. Some nutrients are required on a regular basis, while others are needed less frequently. Poor health can be caused by an imbalance of nutrients, whether an excess or a deficiency.

Carbohydrates: Calories/gram: 4

Carbohydrates may be classified as monosaccharides, disaccharides, or polysaccharides by the number of sugar units they contain. Monosaccharides contain 1 sugar unit, disaccharides contain 2, and polysaccharides contain 3 or more. Polysaccharides are often referred to as complex carbohydrates because they are long chains of sugar units, whereas monosaccharides and disaccharides are simple carbohydrates. The difference is important to nutritionists because complex carbohydrates take longer to metabolize since their sugar units are processed one-by-one off the ends of the chains. Simple carbohydrates are metabolized quickly and thus raise blood sugar levels more quickly resulting in rapid increases in blood insulin levels compared to complex carbohydrates.

Fat: Calories/gram: 9
Fats are composed of fatty acids (long carbon/hydrogen chains) bonded to a glycerol. Fat may be classified as saturated or unsaturated. Saturated fats have all of their carbon atoms bonded to hydrogen atoms, whereas unsaturated fats have some of their carbon atoms double-bonded in place of a hydrogen atom. Generally, saturated fat is solid at room temperature while unsaturated fat is a liquid. Unsaturated fats may be further classified as mono-unsaturated (one double-bond) or poly-unsaturated (many double-bonds). Trans fats are saturated fats which are typically created from unsaturated fat by adding the extra hydrogen atoms in a process called hydrogenation (also called hydrogenated fat).

Fibre: Calories/gram: 0
Dietary fibre consists mainly of cellulose that is indigestible because we do not have enzymes to digest it. Fruits and vegetables are rich in dietary fiber. Importance of dietary fibre:

- provides bulk to the intestinal contents
- stimulates peristalsis (rhythmic muscular contractions passing along the digestive tract)
- Lack of dietary fiber in the diet leads to constipation (failure to pass motions).

Protein: Calories/gram: 4
Most meats such as chicken contain all the essential amino acids needed for humans. Protein is composed of amino acids that are body's structural (muscles, skin, hair etc.) materials. The body requires amino acids to produce new body protein (protein retention) and to replace damaged proteins (maintenance) that are lost in the urine. In animals amino acid requirements are classified in terms of essential (an animal cannot produce them) and non-essential (the animal can produce them from other nitrogen containing compounds) amino acids. Consuming a diet that contains adequate amounts of essential (but also non-essential) amino acids is particularly important for growing animals, who have a particularly high requirement. Dietary sources of protein include meats, eggs, grains, legumes, and dairy products such as milk and cheese. Proteins can be converted into carbohydrates through a process called gluconeogenesis.

Minerals: Calories/gram: 0
Dietary minerals are the chemical elements required by living organisms, other than the four elements carbon, hydrogen, nitrogen, and oxygen which are present in common organic molecules. The term "mineral" is archaic, since the intent of the definition is to describe ions, not chemical compounds or actual minerals. Some dietitians recommend that these heavier elements should be supplied by ingesting specific foods (that are enriched in the element(s) of interest), compounds, and sometimes including even minerals, such as calcium carbonate. Sometimes these "minerals" come from natural sources such as ground oyster shells. Sometimes minerals are added to the diet separately from food, such as mineral supplements, the most famous being iodine in "iodized salt."

Macrominerals
A variety of elements are required to support the biochemical processes, many play a role as electrolytes or in a structural role. In Human nutrition, the dietary bulk "mineral elements" (RDA > 200 mg/day) are in alphabetical order (parenthetical comments on folk medicine perspective):

- Calcium (for muscle and digestive system health, builds bone, neutralizes acidity, clears toxins, helps blood stream)
- Chloride
- Magnesium required for processing ATP and related reactions (health, builds bone, causes strong peristalsis, increases flexibility, increases alkalinity)
- Phosphorus required component of bones and energy processing and many other functions (bone mineralization)
- Potassium required electrolyte (heart and nerves health)

- Sodium electrolyte
- Sulfur for three essential amino acids and many proteins and cofactors (skin, hair, nails, liver, and pancreas health)

Trace minerals

A variety of elements are required in trace amounts, unusually because they play a role in catalysis in enzymes. Some trace mineral elements (RDA < 200 mg/day) are (alphabetical order):

- Cobalt required for bio-synthesized of vitamin B12 family of coenzymes
- Copper required component of many redox enzymes, including cytochrome c oxidase
- Chromium required for sugar metabolism
- Iodine required for the biosynthesis of thyroxine
- Iron required for many proteins and enzymes, notably hemoglobin
- Manganese (processing of oxygen)
- Molybdenum required for xanthine oxidase and related oxidases
- Nickel present in urease. (**Urease** (EC 3.5.1.5) is an enzyme that catalyzes the hydrolysis of urea into carbon dioxide and ammonia. The reaction occurs as follows: (NH2)2CO + H_2O → CO2 + 2NH3, Urea + Water --^{urease}--> Ammonium Carbonate

In 1926 James Sumner showed that urease is a protein. Urease is found in bacteria, yeast and several higher plants.

- Selenium required for peroxidase (antioxidant proteins)
- Vanadium (There is no established RDA for vanadium. No specific biochemical function has been identified for it in humans, although vanadium is found in lower organisms.)
- Zinc required for several enzymes such as carboxypeptidase, liver alcohol dehydrogenase, carbonic anhydrase. Zinc is pervasive.
- Iodine is required in larger quantities than the other trace minerals in this list and is sometimes classified with the bulk minerals. Sodium is not generally found in dietary supplements, despite being needed in large quantities, because the ion is very common in food.

Vitamins: Calories/gram: 0

Mineral and/or vitamin deficiency or excess may yield symptoms of diminishing health such as goitre, scurvy, osteoporosis, weak immune system, disorders of cell metabolism, certain forms of cancer, symptoms of premature aging, and poor psychological health (including eating disorders), among many others.

As of 2005, twelve vitamins and about the same number of minerals are recognized as "essential nutrients", meaning that they must be consumed and absorbed - or, in the case of vitamin D, alternatively synthesized via UVB radiation - to prevent deficiency symptoms and death. Certain vitamin-like substances found in foods, such as carnitine, have also been found essential to survival and health, but these are not strictly "essential" to eat because the body can produce them from other compounds. Moreover, thousands of different phytochemicals have recently been discovered in food (particularly in fresh vegetables), which have many known and yet to be explored properties including antioxidant activity (see below). Other essential nutrients include essential amino acids, choline and the essential fatty acids.

Water: Calories/gram: 0

About 70% of the non-fat mass of the human body is made of water. To function properly, the body requires between one and seven liters of water per day to avoid dehydration the precise amount depends on the level of activity, temperature, humidity, and other factors. With physical exertion and heat exposure, water loss will increase and daily fluid needs may increase as well.

It is not clear how much water intake is needed by healthy people, although some experts assert that 8–10 glasses of water (approximately 2 liters) daily is the minimum to maintain proper hydration. The notion that a person should consume eight glasses of water per day cannot be traced back to a scientific source. The effect of water on weight loss and constipation is also still unknown. Original recommendation for water intake in 1945 by the Food and Nutrition Board of the National Research Council read: "An ordinary standard for diverse persons is 1 milliliter for each calorie of food. Most of this quantity is contained in prepared foods."The latest dietary reference intake report by the United States National Research Council in general recommended (including food sources): 2.7 liters of water total for women and 3.7 liters for men. Specifically, pregnant and breastfeeding women need additional fluids to stay hydrated. According to the Institute of Medicine—who recommend that, on average, women consume 2.2 litres and men 3.0 litres—this is recommended to be 2.4 litres (approx. 9 cups) for pregnant women and 3 litres (approx. 12.5 cups) for breastfeeding women since an especially large amount of fluid is lost during nursing.

For those who have healthy kidneys, it is rather difficult to drink too much water, but (especially in warm humid weather and while exercising) it is dangerous to drink too little. People can drink far more water than necessary while exercising, however, putting them at risk of water intoxication, which can be fatal.

Normally, about 20 percent of water intake comes from food, while the rest comes from drinking water and beverages (caffeinated included). Water is excreted from the body in multiple forms; through urine and feces, through sweating, and by exhalation of water vapor in the breath.

Other nutrients: Calories/gram: 0

Other micro nutrients include antioxidants, essential fatty acids, and phytochemicals. These substances are generally more recent discoveries which: have not yet been recognized as vitamins; are still under investigation; or contribute to health but are not necessary for life. Phytochemicals may act as antioxidants, but not all phytochemicals are antioxidants.

Antioxidants

Antioxidants are a recent discovery. As cellular metabolism/energy production requires oxygen, potentially damaging (e.g. mutation causing) compounds known as radical oxygen species or free radicals form as a result. For normal cellular maintenance, growth, and division, these free radicals must be sufficiently neutralized by antioxidant compounds, some produced by the body with adequate precursors (glutathione, Vitamin C in most animals) and those that the body cannot produce may only be obtained through the diet through direct sources (Vitamin C in humans, Vitamin A, Vitamin K) or produced by the body from other compounds (Beta-carotene converted to Vitamin A by the body, Vitamin D synthesized from cholesterol by sunlight). Phytochemicals (*Section Below*) and their subgroup polyphenols comprise of the majority of antioxidants, some 4,000 known, and therefore there is much overlap. Different antioxidants are now known to function in a cooperative network, e.g. vitamin C can reactivate free radical-containing glutathione or vitamin E by accepting the free radical itself, and so on. Some antioxidants are more effective than others at neutralizing different free radicals. Some cannot neutralize certain free radicals. Some cannot be present in certain areas of free radical development (Vitamin A is fat-soluble and protects fat areas, Vitamin C is water soluble and protects those areas). When interacting with a free radical, some antioxidants produce a different free radical compound that is less dangerous or more dangerous than the previous compound. Having a variety of antioxidants allows any byproducts to be safely dealt with by more efficient antioxidants in neutralizing a free radicals butterfly effect.

Essential fatty acids

Most fatty acids are non-essential, meaning the body can produce them as needed, however, at least two fatty acids are essential and must be consumed in the diet. An appropriate balance of essential fatty acids - omega-3 and omega-6 fatty acids - has been discovered to be important for maintaining health. Both of these unique "omega" long-chain polyunsaturated fatty acids are substrates for a class of eicosanoids known as prostaglandins which function as hormones. The omega-3 eicosapentaenoic acid (EPA) (which can be made in the body from the omega-3 essential fatty acid alpha-linolenic acid (LNA), or taken in through marine food sources), serves as building block for series 3 prostaglandins (e.g. weakly-inflammation PGE3). The omega-6 dihomo-gamma-linolenic acid (DGLA) serves as building block for series 1 prostaglandins (e.g. anti-inflammatory PGE1), whereas arachidonic acid (AA) serves as building block for series 2 prostaglandins (e.g. pro-inflammatory PGE 2). Both DGLA and AA are made from the omega-6 linoleum acid (LA) in the body, or can be taken in directly through food. An appropriately balanced intake of omega-3 and omega-6 partly determines the relative production of different prostaglandins, which partly explains the importance of omega-3/omega-6 balance for cardiovascular health. In industrialized societies, people generally consume large amounts of processed vegetable oils that have reduced amounts of essential fatty acids along with an excessive amount of omega-6 relative to omega-3.

The rate of conversions of omega-6 DGLA to AA largely determines the production of the respective prostaglandins PGE1 and PGE2. Omega-3 EPA prevents AA from being released from membranes, thereby skewing prostaglandin balance away from pro-inflammatory PGE2 made from AA toward anti-inflammatory PGE1 made from DGLA. Moreover, the conversion (desaturation) of DGLA to AA is controlled by the enzyme delta-5-desaturase, which in turn is controlled by hormones such as insulin (up-regulation) and glucagon (down-regulation). Because different types and amounts of food eaten/absorbed affect insulin, glucagon and other hormones to varying degrees, not only the amount of omega-3 versus omega-6 eaten but also the general composition of the diet therefore determine health implications in relation to essential fatty acids, inflammation (e.g. immune function) and mitosis (i.e. cell division).

Phytochemicals

Blackberries are a source of polyphenol antioxidants. A growing area of interest is the effect upon human health of trace chemicals, collectively called phytochemicals. These nutrients are typically found in edible plants, especially colorful fruits and vegetables, but also other organisms including seafood, algae, and fungi. The effects of phytochemicals increasingly survive rigorous testing by prominent health organizations. One of the principal classes of phytochemicals are polyphenol antioxidants, chemicals which are known to provide certain health benefits to the cardiovascular system and immune system. These chemicals are known to down-regulate the formation of reactive oxygen species, key chemicals in cardiovascular disease.

Perhaps the most rigorously tested phytochemical is zeaxanthin, a yellow-pigmented carotenoid present in many yellow and orange fruits and vegetables. Repeated studies have shown a strong correlation between ingestion of zeaxanthin and the prevention and treatment of age-related macular degeneration (AMD). Less rigorous studies have proposed a correlation between zeaxanthin intake and cataracts. A second carotenoid, lutein, has also been shown to lower the risk of contracting AMD. Both compounds have been observed to collect in the retina when ingested orally, and they serve to protect the rods and cones against the destructive effects of light.

Another caretenoid, beta-cryptoxanthin, appears to protect against chronic joint inflammatory diseases, such as arthritis. While the association between serum blood levels of beta-cryptoxanthin and substantially decreased joint disease has been established, neither a convincing mechanism for such protection nor a cause-and-effect have been rigorously studied. Similarly, a red phytochemical, lycopene, has substantial credible evidence of negative association with development of prostate cancer.

The correlations between the ingestion of some phytochemicals and the prevention of disease are, in some cases, enormous in magnitude.

Even when the evidence is obtained, translating it to practical dietary advice can be difficult and counter-intuitive. Lutein, for example, occurs in many yellow and orange fruits and vegetables and protects the eyes against various diseases. However, it does not protect the eye nearly as well as zeaxanthin, and the presence of lutein in the retina will prevent zeaxanthin uptake. Additionally, evidence has shown that the lutein present in egg yolk is more readily absorbed than the lutein from vegetable sources, possibly because of fat solubility. At the most basic level, the question "should you eat eggs?" is complex to the point of dismay, including misperceptions about the health effects of cholesterol in egg yolk, and its saturated fat content.

As another example, lycopene is prevalent in tomatoes (and actually is the chemical that gives tomatoes their red color). It is more highly concentrated, however, in processed tomato products such as commercial pasta sauce, or tomato soup, than in fresh "healthy" tomatoes. Yet, such sauces tend to have high amounts of salt, sugar, other substances a person may wish or even need to avoid.

The following table presents phytochemical groups and common sources, arranged by family:

Family	Sources	Possible Benefits
flavonoids	berries, herbs, vegetables, wine, grapes, green tea	general antioxidant, oxidation of LDLs, prevention of arteriosclerosis and heart disease
isoflavones (phytoestrogens)	soy, red clover, kudzu root	general antioxidant, prevention of arteriosclerosis and heart disease, easing symptoms of menopause, cancer prevention
isothiocyanates	cruciferous vegetables	cancer prevention
monoterpenes	citrus peels, essential oils, herbs, spices, green plants, atmosphere	cancer prevention, treating gallstones
organosulfur compounds	chives, garlic, onions	cancer prevention, lowered LDLs, assistance to the immune system
saponins	beans, cereals, herbs	Hypercholesterolemia, Hyperglycemia, Antioxidant, cancer prevention, Anti-inflammatory
capsaicinoids	all capsicum (chili) peppers	topical pain relief, cancer prevention, cancer cell apoptosis

Intestinal bacterial flora

It is now also known that the human digestion system contains a population of a range of bacteria and yeast such as Bacteroides, L. acidophilus and E. coli which are essential to digestion, and which are also affected by the food we eat. Bacteria in the gut fulfill a host of important functions for humans, including breaking down and aiding in the absorption of otherwise indigestible food; stimulating cell growth; repressing the growth of harmful bacteria, training the immune system to respond only to pathogens; and defending against some diseases.

Balanced diet

Balanced diet is a diet which consists of all the nutrients in a required proportion with water and roughage.

Junk food

Junk food is a slang name for food items containing limited nutritional value. It includes food high in salts, fats, sugar, and calories, and low nutrient content.

Nutrition for anaerobic exercise

After weight training, the body is depleted of glycogen stores. This creates a rise in Glycogen synthetase, which allows for a greater amount of glycogen synthesis for a period after training. To compensate for this glycogen depletion, athletes will often take in a large amount of carbohydrates in the period immediately following exercise. Typically, high glycemic index carbohydrates are preferred for their ability to raise insulin levels, thus increasing rate of nutrient storage. Recently, High Molecular Weight carbohydrates have come to prominence for their low osmolality, and potential for quicker, and greater glycogen restoration.

For the purpose of protein synthesis, amino acids are ingested as well. Studies also show that there is a greater rate of glycogen synthesis when amino acids are included with the ingested carbohydrate.

Nutrition for aerobic exercise

After the aerobic exercise it is necessary to fill the glycogen stores in the muscles. A liquid source of fast carbohydrates and protein in ratio 4:1 are generally recommended for optimal recovery.

Antioxidants are essential to maintaining cellular health in the body during the periods of high oxidative stress that occur during aerobic exercise. They can be consumed in the diet (commonly found in tea, coffee, fruits and vegetables) or are easily found in a wide range of nutritional supplements. Superoxide dismutase is a particularly effective enzyme with strong clinical support for enhanced athletic performance, especially when bound with gliadin to form glisodin.

Goals of sport nutrition

Some of the main goals of sport nutrition are to:

- prepare athlete for performance or training (before)
- maintain the level of performance or training (during)
- help recovery from performance or training (after)

In some sports, nutrition is also necessary in maintaining a body aesthetic (bodybuilding) or body weight (cycling).

Protein

The protein requirements of athletes, once the source of great controversy, has settled into a current consensus. Sedentary people and recreational athletes have similar protein requirements, about 1 gram of protein per kilogram of body mass. These needs are easily met by a balanced diet containing about 70 grams of protein for a 70 kg (150 pound) man or 60 grams of protein for a 60 kg (130 pound) woman.

People who exercise at greater intensity, and especially those whose activity grows muscle bulk, have significantly higher protein requirements. According to *Clinical Sports Nutrition* (see footnote above), active athletes playing power sports (such as football), those engaged in muscle-development training, and elite endurance athletes, all require approximately 2 grams of protein per day per kilogram of body weight, roughly double that of a sedentary persons. Older athletes seeking primarily to maintain developed muscle mass require 2 to 3 g per day per kg. Protein intake in excess of that required to build muscle (and other) tissue is broken-down by gluconeogenesis to be used as energy.

Water and salts

Maintaining hydration during periods of physical exertion is key to good performance. While drinking too much water during activities can lead to physical discomfort, dehydration in excess of 2% of body mass (by weight) markedly hinders athletic performance. It is recommended that an athlete drink about 400-600 mL 2-3 hours before activity, during exercise he or she should drink 150-350mL every 15 to 20 minutes and after exercise that he or she replace sweat loss by drinking 450-675 mL for every 0.5 kg body weight loss during activity. Some studies have shown that an athlete that drinks before they feel thirsty stays cooler and performs better than one who drinks on thirst cues, although recent studies of such races as the Boston Marathon have indicated that this recommendation can lead to the problem of over hydration. Additional carbohydrates and protein before, during, and after exercise increase time to exhaustion as well as speed recovery. Dosage is based on work performed, lean body mass, and environmental factors, especially ambient temperature and humidity.

Carbohydrates

The main fuel used by the body during exercise is carbohydrates, which is stored in muscle as glycogen- a form of sugar. During exercise, muscle glycogen reserves can be used up, especially when activities last longer than 90 min. When glycogen is not present in muscles, the muscle cells perform anaerobic respiration producing lactic acid, which is responsible for fatigue and burning sensation, and post exercise stiffness in muscles. Because the amount of glycogen stored in the body is limited, it is important for athletes to replace glycogen by consuming a diet high in carbohydrates. Meeting energy needs can help improve performance during the sport, as well as improve overall strength and endurance.

There are different kinds of carbohydrates--simple or refined, and unrefined. A typical American consumes about 50% of their carbohydrates as simple sugars, which are added to foods as opposed to sugars that come naturally in fruits and vegetables. These simple sugars come in large amounts in sodas and fast food. Over the course of a year, the average American consumes 54 gallons of soft drinks, which contain the highest amount of added sugars. Even though carbohydrates are necessary for humans to function, they are not all equally healthful. When machinery has been used to remove bits of high fiber, the carbohydrates are refined. These are the carbohydrates found in white bread and fast food.

Longevity: Whole plant food diet

Heart disease, cancer, obesity, and diabetes are commonly called "Western" diseases because these maladies were once rarely seen in developing countries. One study in China found some regions had essentially no cancer or heart disease, while in other areas they reflected "up to a 100-fold increase" coincident with diets that were found to be entirely plant-based to heavily animal-based, respectively. In contrast, diseases of affluence like cancer and heart disease are common throughout the United States. Adjusted for age and exercise, large regional clusters of people in China rarely suffered from these "Western" diseases possibly because their diets are rich in vegetables, fruits and whole grains.

The United Health care/ Pacificare nutrition guideline recommends a whole plant food diet, and recommends using protein only as a condiment with meals. A National Geographic cover article from November, 2005, entitled *The Secrets of Living Longer*, also recommends a whole plant food diet. The article is a lifestyle survey of three populations, Sardinians, Okinawans, and Adventists, who generally display longevity and "suffer a fraction of the diseases that commonly kill people in other parts of the developed world, and enjoy more healthy years of life. In sum, they offer three sets of 'best practices' to emulate. The rest is up to you." In common with all three groups is to "Eat fruits, vegetables, and whole grains."

The *National Geographic* article noted that an NIH funded study of 34,000 Seventh-day Adventists between 1976 and 1988 "...found that the Adventists' habit of consuming beans, soy milk, tomatoes, and other fruits lowered their risk of developing certain cancers. It also suggested that eating whole grain bread, drinking five glasses of water a day, and, most surprisingly, consuming four servings of nuts a week reduced their risk of heart disease."

The French "paradox"
It has been discovered that people living in France live longer. Even though they consume more saturated fats than Americans, the rate of heart disease is lower in France than in North America. A number of explanations have been suggested:

- Reduced consumption of processed carbohydrate and other junk foods;
- Ethnic genetic differences allowing the body to be harmed less by fats;
- Regular consumption of red wine.
- Living in the South requires the body to produce less heat, allowing a slower, and therefore healthier, metabolic rate.
- More active lifestyles involving plenty of daily exercise, especially walking; the French are much less dependent on cars than Americans are.
- Higher consumption of artificially produced trans-fats by Americans, which has been shown to have greater lipoprotein impacts per gram than saturated fat.

However, a growing number of French health researchers doubt the theory that the French are healthier than other populations. Statistics collected by the WHO from 1990-2000 show that the incidence of heart disease in France may have been underestimated and in fact be similar to that of neighboring countries.

Malnutrition
Malnutrition refers to insufficient, excessive, or imbalanced consumption of nutrients. In developed countries, the diseases of malnutrition are most often associated with nutritional imbalances or excessive consumption. Although there are more people in the world who are malnurished due to excessive consumption, according to the United Nations World Health Organization, the real challenge in developing nations today, more than starvation, is insufficient malnutrition — the lack of nutrients necessary for growth and the maintenance of vital functions.

Illnesses caused by improper nutrient consumption

NUTRIENTS	DEFICIENCY	EXCESS
Calories	Starvation	Obesity, diabetes mellitus, Cardiovascular disease
Simple carbohydrates	Marasmus, starvation	diabetes mellitus
Complex carbohydrates	Marasmus, starvation	Obesity
Saturated fat / trans fat	none	Cardiovascular disease,
Unsaturated fat	Rabbit starvation	Obesity
Cholesterol	none	Cardiovascular disease
Protein	Marasmus	Ketoacidosis, Rabbit starvation, kidney disease
Sodium	hyponatremia	Hypernatremia, hypertension
Iron	Anemia	Hepatitis C, cirrhosis, heart disease
Iodine	Goiter, hypothyroidism	Iodine Toxicity (goiter, hypothyroidism)
Vitamin A	Xeropthalmia and Night Blindness	Hypervitaminosis A (cirrhosis, hair loss, birth defects)
Vitamin B_1	Beri-Beri	
Vitamin B2	Cracking of skin and Corneal Unclearation	
Niacin	Pellagra	dyspepsia, cardiac arrhythmias, birth defects
Vitamin B12	Pernicious Anemia	
Vitamin C	Scurvy	
Vitamin D	Rickets	Hypervitaminosis D (dehydration, vomiting, constipation)
Vitamin E		Hypervitaminosis E (anticoagulant: excessive bleeding)
Vitamin K	Hemorrhage	

Mental agility

Research indicates that improving the awareness of nutritious meal choices and establishing long-term habits of healthy eating has a positive effect on a cognitive and spatial memory capacity, potentially increasing a student's potential to process and retain academic information. Some organizations have begun working with teachers, policymakers, and managed food service contractors to mandate improved nutritional content and increased nutritional resources in school cafeterias from primary to university level institutions. Health and nutrition have been proven to have close links with overall educational success (Behrman, 1996). Currently less than 10% of American college students report that they ate the recommended five servings of fruit and vegetables daily. Better nutrition has been shown to have an impact on both cognitive and spatial memory performance; a study showed those with higher blood sugar levels performed better on certain memory tests. In another study, those who consumed yogurt performed better on thinking tasks when compared to those who consumed caffeine free diet soda or confections. Nutritional deficiencies have been shown to have a negative effect on learning behavior in mice as far back as 1951.

- "Better learning performance is associated with diet induced effects on learning and memory ability".
- The "nutrition-learning nexus" demonstrates the correlation between diet and learning and has application in a higher education setting.
- "We find that better nourished children perform significantly better in school, partly because they enter school earlier and thus have more time to learn but mostly because of greater learning productivity per year of schooling."
- 91% of college students feel that they are in good health while only 7% eat their recommended daily allowance of fruits and vegetables.
- Nutritional education is an effective and workable model in a higher education setting.
- More "engaged" learning models that encompass nutrition is an idea that is picking up steam at all levels of the learning cycle.

There is limited research available that directly links a student's Grade Point Average (G.P.A.) to their overall nutritional health. Additional substantive data is needed to prove beyond a shadow of a doubt that overall intellectual health is closely linked to a person's diet, rather than just another correlation fallacy.

Mental disorders
Nutritional supplement treatment may be appropriate for major depression, bipolar disorder, schizophrenia, and obsessive compulsive disorder, the four most common mental disorders in developed countries.

Cancer
Cancer is now common in developing countries. According a study by the International Agency for Research on Cancer, "In the developing world, cancers of the liver, stomach and esophagus were more common, often linked to consumption of carcinogenic preserved foods, such as smoked or salted food, and parasitic infections that attack organs." Lung cancer rates are rising rapidly in poorer nations because of increased use of tobacco. Developed countries "tended to have cancers linked to affluence or a 'Western lifestyle' – cancers of the colon, rectum, breast and prostate – that can be caused by obesity, lack of exercise, diet and age."

Metabolic syndrome
Several lines of evidence indicate lifestyle-induced hyperinsulinemia and reduced insulin function (i.e. insulin resistance) as a decisive factor in many disease states. For example, hyperinsulinemia and insulin resistance are strongly linked to chronic inflammation, which in turn is strongly linked to a variety of adverse developments such as arterial microinjuries and clot formation (i.e. heart disease) and exaggerated cell division (i.e. cancer). Hyperinsulinemia and insulin resistance (the so-called metabolic syndrome) are characterized by a combination of abdominal obesity, elevated blood sugar, elevated blood pressure, elevated blood triglycerides, and reduced HDL cholesterol. The negative impact of hyperinsulinemia on prostaglandin PGE1/PGE2 balance may be significant.

The state of obesity clearly contributes to insulin resistance, which in turn can cause type 2 diabetes. Virtually all obese and most type 2 diabetic individuals have marked insulin resistance. Although the association between overweight and insulin resistance is clear, the exact (likely multifarious) causes of insulin resistance remain less clear. Importantly, it has been demonstrated that appropriate exercise, more regular food intake and reducing glycemic load all can reverse insulin resistance in overweight individuals (and thereby lower blood sugar levels in those who have type 2 diabetes).

Obesity can unfavorably alter hormonal and metabolic status via resistance to the hormone leptin, and a vicious cycle may occur in which insulin/leptin resistance and obesity aggravate one another. The vicious cycle is putatively fueled by continuously high insulin/leptin stimulation and fat storage, as a result of high intake of strongly insulin/leptin stimulating foods and energy. Both insulin and leptin normally function as satiety signals to the hypothalamus in the brain; however, insulin/leptin resistance may reduce this signal and therefore allow continued overfeeding despite large body fat stores. In addition, reduced leptin signaling to the brain may reduce leptin's normal effect to maintain an appropriately high metabolic rate.

There is a debate about how and to what extent different dietary factors -- e.g. intake of processed carbohydrates, total protein, fat, and carbohydrate intake, intake of saturated and trans fatty acids, and low intake of vitamins/minerals -- contribute to the development of insulin- and leptin resistance. In any case, analogous to the way modern man-made pollution may potentially overwhelm the environment's ability to maintain 'homeostasis', the recent explosive introduction of high Glycemic Index- and processed foods into the human diet may potentially overwhelm the body's ability to maintain homeostasis and health (as evidenced by the metabolic syndrome epidemic).

Hyponatremia

Excess water intake, without replenishment of sodium and potassium salts, leads to hyponatremia, which can further lead to water intoxication at more dangerous levels. A well-publicized case occurred in 2007, when Jennifer Strange died while participating in a water-drinking contest. More usually, the condition occurs in long-distance endurance events (such as marathon or triathlon competition and training) and causes gradual mental dulling, headache, drowsiness, weakness, and confusion; extreme cases may result in coma, convulsions, and death. The primary damage comes from swelling of the brain, caused by increased osmosis as blood salinity decreases. Effective fluid replacement techniques include Water aid stations during running/cycling races, trainers providing water during team games such as Soccer and devices such as Camel Backs which can provide water for a person without making it too hard to drink the water.

Processed foods

Since the Industrial Revolution some two hundred years ago, the food processing industry has invented many technologies that both help keep foods fresh longer and alter the fresh state of food as they appear in nature. Cooling is the primary technology used to maintain freshness, whereas many more technologies have been invented to allow foods to last longer without becoming spoiled. These latter technologies include pasteurization, autoclavation, drying, salting, and separation of various components, and all appear to alter the original nutritional contents of food. Pasteurization and autoclavation (heating techniques) have no doubt improved the safety of many common foods, preventing epidemics of bacterial infection. But some of the (new) food processing technologies undoubtedly have downfalls as well.

Modern separation techniques such as milling, centrifugation, and pressing have enabled up concentration of particular components of food, yielding flour, oils, juices and so on, and even separate fatty acids, amino acids, vitamins, and minerals. Inevitably, such large scale up concentration changes the nutritional content of food, saving certain nutrients while removing others. Heating techniques may also reduce food's content of many heat-labile nutrients such as certain vitamins and phytochemicals, and possibly other yet to be discovered substances. Because of reduced nutritional value, processed foods are often 'enriched' or 'fortified' with some of the most critical nutrients (usually certain vitamins) that were lost during processing. Nonetheless, processed foods tend to have an inferior nutritional profile compared to whole, fresh foods, regarding content of both sugar and high GI starches, potassium/sodium, vitamins, fibre, and of intact, unoxidized (essential) fatty acids. In addition, processed foods often contain potentially harmful substances such as oxidized fats and trans fatty acids.

A dramatic example of the effect of food processing on a population's health is the history of epidemics of beri-beri in people subsisting on polished rice. Removing the outer layer of rice by polishing it removes with it the essential vitamin thiamine, causing beri-beri. Another example is the development of scurvy among infants in the late 1800s in the United States. It turned out that the vast majority of sufferers were being fed milk that had been heat-treated (as suggested by Luis Pasteur) to control bacterial disease. Pasteurization was effective against bacteria, but it destroyed the vitamin C. As mentioned, lifestyle- and obesity-related diseases are becoming increasingly prevalent all around the world. There is little doubt that the increasingly widespread application of some modern food processing technologies has contributed to this development. The food processing industry is a major part of modern economy, and as such it is influential in political decisions (e.g. nutritional recommendations, agricultural subsidizing). In any known profit-driven economy, health considerations are hardly a priority; effective production of cheap foods with a long shelf-life is more the trend. In general, whole, fresh foods have a relatively short shelf-life and are less profitable to produce and sell than are more processed foods. Thus the consumer is left with the choice between more expensive but nutritionally superior whole, fresh foods, and cheap, usually nutritionally inferior processed foods. Because processed foods are often cheaper, more convenient (in both purchasing, storage, and preparation), and more available, the consumption of nutritionally inferior foods has been increasing throughout the world along with many nutrition-related health complications.

Governmental policies

The updated USDA food pyramid, published in 2005, is a general nutrition guide for recommended food consumption for humans.

In the US, dietitians. are registered (RD) or licensed (LD) with the Commission for Dietetic Registration and the American Dietetic Association, and are only able to use the title "dietitian," as described by the business and professions codes of each respective state, when they have met specific educational and experiential prerequisites and passed a national registration or licensure examination, respectively. In California, registered dietitians must abide by the Business and Professions Code of Section 2585-2586.8.Anyone may call themselves a nutritionist, including unqualified personnel, as this term is unregulated. Some states, such as the State of Florida, have begun to include the title "nutritionist" in state licensure requirements. Most governments provide guidance on nutrition, and some also impose mandatory disclosure/labeling requirements for processed food manufacturers and restaurants to assist consumers in complying with such guidance.

In the US, nutritional standards and recommendations are currently controlled by the US Department of Agriculture. Dietary and exercise guidelines from the USDA are presented in the concept of a food pyramid, which superseded the Four Food Groups. The Senate committee currently responsible for oversight of the USDA is the *Agriculture, Nutrition and Forestry Committee*. Committee hearings are often televised on C-SPAN as seen here.

The U.S. Department of Health and Human Services provides a sample week-long menu which fulfills the nutritional recommendations of the government. Canada's Food Guide is another governmental recommendation.

Teaching

Nutrition is taught in schools in many countries. In England and Wales the Personal and Social Education and Food Technology curricula include nutrition, stressing the importance of a balanced diet and teaching how to read nutrition labels on packaging.

History

Humans have evolved as omnivorous hunter-gatherers over the past 250,000 years. The diet of early modern humans varied significantly depending on location and climate. The diet in the tropics tended to be based more heavily on plant foods, while the diet at higher latitudes tended more towards animal products. Analysis of post cranial and cranial remains of humans and animals from the Neolithic, along with detailed bone modification studies have shown that cannibalism was also prevalent among prehistoric humans.

Agriculture developed about 10,000 years ago in multiple locations throughout the world, providing grains such as wheat, rice, and maize, with staples such as bread and pasta. Farming also provided milk and dairy products, and sharply increased the availability of meats and the diversity of vegetables. The importance of food purity was recognized when bulk storage led to infestation and contamination risks. Cooking developed as an often ritualistic activity, due to efficiency and reliability concerns requiring adherence to strict recipes and procedures, and in response to demands for food purity and consistency.

Antiquity through 1900

- The first recorded nutritional experiment is found in the Bible's Book of Daniel. Daniel and his friends were captured by the king of Babylon during an invasion of Israel. Selected as court servants, they were to share in the king's fine foods and wine. But they objected, preferring vegetables (pulses) and water in accordance with their Jewish dietary restrictions. The king's chief steward reluctantly agreed to a trial. Daniel and his friends received their diet for 10 days and were then compared to the king's men. Appearing healthier, they were allowed to continue with their diet.
- c. 475 BC: Anaxagoras states that food is absorbed by the human body and therefore contained "homeomerics" (generative components), thereby deducing the existence of nutrients.
- c. 400 BC: Hippocrates says, "Let food be your medicine and medicine be your food."
- 1500s: Scientist and artist Leonardo da Vinci compared metabolism to a burning candle.
- 1747: Dr. James Lind, a physician in the British navy, performed the first scientific nutrition experiment, discovering that lime juice saved sailors who had been at sea for years from scurvy, a deadly and painful bleeding disorder. The discovery was ignored for forty years, after which British sailors became known as "limeys." The essential vitamin C within lime juice would not be identified by scientists until the 1930s.
- 1770: Antoine Lavoisier, the "Father of Nutrition and Chemistry" discovered the details of metabolism, demonstrating that the oxidation of food is the source of body heat.
- 1790: George Fordyce recognized calcium as necessary for fowl survival.
- Early 1800s: The elements carbon, nitrogen, hydrogen and oxygen were recognized as the primary components of food, and methods to measure their proportions were developed.
- 1816: François Magendie discovers that dogs fed only carbohydrates and fat lost their body protein and died in a few weeks, but dogs also fed protein survived, identifying protein as an essential dietary component.
- 1840: Justus Liebig discovers the chemical makeup of carbohydrates (sugars), fats (fatty acids) and proteins (amino acids.)
- 1860s: Claude Bernard discovers that body fat can be synthesized from carbohydrate and protein, showing that the energy in blood glucose can be stored as fat or as glycogen.
- Early 1880s: Kanehiro Takaki observed that Japanese sailors (whose diets consisted almost entirely of white rice) developed beri-beri (or endemic neuritis, a disease causing heart problems and paralysis) but British sailors and Japanese naval officers did not. Adding various types of vegetables and meats to the diets of Japanese sailors prevented the disease.

- 1896: Baumann observed iodine in thyroid glands.
- 1897: Christiaan Eijkman worked with natives of Java, who also suffered from beriberi. Eijkman observed that chickens fed the native diet of white rice developed the symptoms of beriberi, but remained healthy when fed unprocessed brown rice with the outer bran intact. Eijkman cured the natives by feeding them brown rice, discovering that food can cure disease. Over two decades later, nutritionists learned that the outer rice bran contains vitamin B1, also known as thiamine.

1900 through 1941

- Early 1900s: Carl Von Voit and Max Rubner independently measure caloric energy expenditure in different species of animals, applying principles of physics in nutrition.
- 1906: Wilcock and Hopkins showed that the amino acid tryptophan was necessary for the survival of mice. Gowland Hopkins recognized "accessory food factors" other than calories, protein and minerals, as organic materials essential to health but which the body cannot synthesise.
- 1907: Stephen M. Babcock and Edwin B. Hart conduct the single-grain experiment. This experiment runs through 1911.
- 1912: Casimir Funk coined the term vitamin, a vital factor in the diet, from the words "vital" and "amine," because these unknown substances preventing scurvy, beriberi, and pellagra, were thought then to be derived from ammonia.
- 1913: Elmer McCollum discovered the first vitamins, fat soluble vitamin A, and water soluble vitamin B (in 1915; now known to be a complex of several water-soluble vitamins) and names vitamin C as the then-unknown substance preventing scurvy. Lafayette Mendel and Thomas Osborne also perform pioneering work on vitamin A and B.
- 1919: Sir Edward Mellanby incorrectly identified rickets as a vitamin A deficiency, because he could cure it in dogs with cod liver oil.
- 1922: McCollum destroys the vitamin A in cod liver oil but finds it still cures rickets, naming vitamin D
- 1922: H.M. Evans and L.S. Bishop discover vitamin E as essential for rat pregnancy, originally calling it "food factor X" until 1925.
- 1925: Hart discovers trace amounts of copper are necessary for iron absorption.
- 1927: Adolf Otto Reinhold Windaus synthesizes vitamin D, for which he won the Nobel Prize in Chemistry in 1928.
- 1928: Albert Szent-Györgyi isolates ascorbic acid, and in 1932 proves that it is vitamin C by preventing scurvy. In 1935 he synthesizes it, and in 1937 he wins a Nobel Prize for his efforts. Szent-Györgyi concurrently elucidates much of the citric acid cycle.
- 1930s: William Cumming Rose identifies essential amino acids, necessary protein components which the body cannot synthesize.
- 1935: Underwood and Marston independently discover the necessity of cobalt.
- 1936: Eugene Floyd Dubois shows that work and school performance are related to caloric intake.
- 1938: The chemical structure of vitamin E is discovered by Erhard Fernholz, and it is synthesised by Paul Karrer.
- 1940 UK institutes rationing according to nutritional principles drawn up by Elsie Widdowson and others
- 1941: The first Recommended Dietary Allowances (RDAs) were established by the National Research Council.

Recent

- 1992 The U.S. Department of Agriculture Introduces Food Guide Pyramid
- 2002 Study shows relation between nutrition and violent behavior
- 2005 Obesity may be caused by adenovirus in addition to bad nutrition