Fundamentals of Clinical Nutrition

Clinical nutrition is the study of the relationship between food, the maintenance of health and the prevention of disease. Additionally, it is the science of nutrients and how they are digested, absorbed, transported, metabolized, stored, and eliminated by the body. Also, the study of clinical nutrition focuses on how the environment affects the quality and safety of foods, and what influence these factors have on health and disease.

“The study of nutrition dates back to the 18th century, when the French chemist Lavoisier discovered that there was a relationship between the metabolism of food and the process of breathing. By the early 20th century, scientists had found that diseases -- such as beri-beri, rickets, scurvy, and pellagra -- were associated with certain diets. By 1912, the Polish chemist Casimir Funk had found a substance (vitamin B1) that actually prevented beri-beri, and he named it "vitamine." Later it was found that these diseases were caused by the lack of specific nutrients -- vitamin B1 (thiamine), vitamin D, vitamin C, and vitamin B3 (niacin) respectively.” [1]

Before the discovery of vitamins and minerals, the U.S. Department of Agriculture (USDA) published its first dietary recommendations to the nation in 1894. Soon after that, in 1916, the first food guide, called Food For Young Children was published. Caroline Hunt, a nutritionist and the author, divided food into 5 groups: milk/meat, cereals, vegetables/fruits, fats/fatty foods, and sugars/sugary foods. [2]

In 1941, at the urging of President Franklin Roosevelt, a National Nutrition Conference was called to action .At this time, the United States Department of Agriculture(USDA) came up with Recommended Dietary Allowances (RDA’s) for Americans to follow. RDA’s specified caloric intake as well as essential nutrients. The concept of the “Basic Four” food groups was introduced and continued to be used until the 1970’s. Milk, meats, fruits and vegetables, and grain products were determined to be the essential food groups.

With the increased incidence of chronic diseases like stroke and heart disease in the 1970’s, the USDA needed to address the roles of unhealthy foods. Consequently, during the late 1970s, the USDA added a fifth category to the Basic Four: fats, sweets and alcoholic beverages, for people to consume in moderation. In 1992 the USDA created the Food Guide Pyramid.

The Dietary Guidelines for Americans has been published jointly every 5 years since 1980 by the Department of Health and Human Services (HHS) and the Department of Agriculture (USDA). The Guidelines provide authoritative advice for people two years and older about how good dietary habits can promote health and reduce risk for major chronic diseases. They serve as the basis for our Federal food and nutrition education programs. [3]

Nutrients

Nutrients are substances obtained from food that perform one or more biochemical or physiological function in the body. The human body has a need for over fifty different nutrients. There are six general classes of nutrients that are considered necessary in human nutrition; carbohydrates, fats, proteins, vitamins, minerals and water.

Three Major Functions of Nutrients:

- Nutrients provide energy for human metabolism. Carbohydrates and fats are the primary sources of energy.
- Nutrients are essential for tissue growth and repair. Protein is the major building material for muscles, other soft tissues and enzymes while minerals such as calcium and phosphorus make up the skeletal framework.
- Nutrients help regulate body processes such as metabolism.

Nutrients are categorized as either macronutrients (needed in relatively large amounts) or micronutrients (needed in smaller quantities). The macronutrients are carbohydrates, fats, fiber, proteins, and water. The micronutrients are minerals and vitamins.

The macronutrients (excluding fiber and water) provide structural material (amino acids from which proteins are built, and lipids from which cell membranes and some signaling molecules are built), energy. Some of the structural material can be used to generate energy internally, and in either case it is measured in Joules or kilocalories (often called "Calories"). Carbohydrates and proteins provide 17 kJ approximately (4 kcal) of energy per gram, while fats provide 37 kJ (9 kcal) per gram. Vitamins, minerals, fiber, and water do not provide energy, but are required for other metabolic reasons. A third class of dietary material is fiber (ie, non-digestible material such as cellulose). An analysis of fiber will be provided later in the text.

The Molecular Composition of Carbohydrates, Fats and Protein

- Molecules of carbohydrates and fats consist of carbon, hydrogen, and oxygen atoms. Carbohydrates range from simple monosaccharides (glucose, fructose, galactose) to complex polysaccharides (starch).
- Fats are triglycerides, made of assorted fatty acid monomers bound to glycerol. Some fatty acids, but not all, are essential in the diet: they cannot be synthesized in the body.
- Protein molecules contain nitrogen atoms in addition to carbon, oxygen, and hydrogen. The fundamental components of protein are nitrogen-containing amino acids, some of which are essential in the sense that humans cannot make them internally. Some of the amino acids are convertible (with the expenditure of energy) to glucose and can be used for energy production just as ordinary glucose. By breaking down existing protein, some glucose can be produced internally; the remaining amino acids are discarded, primarily as urea in urine. This occurs normally only during prolonged starvation.
- Most foods contain a mix of some or all of the nutrient classes, together with other substances such as toxins or various sorts. Poor health can be caused by a lack of required nutrients or, in extreme cases, too much of a required nutrient. For example, both salt and water (both absolutely required) will cause illness or even death in too large amounts.[4]

Digestion of Nutrients

The digestive process is essential because it breaks large food molecules into smaller molecules that can be absorbed into the villi of the small intestine and eventually travel through the blood. Simple molecules can then dissolve in blood and go into circulation to reach every part of the body. There are two types of digestion, physical and chemical.

Physical Digestion

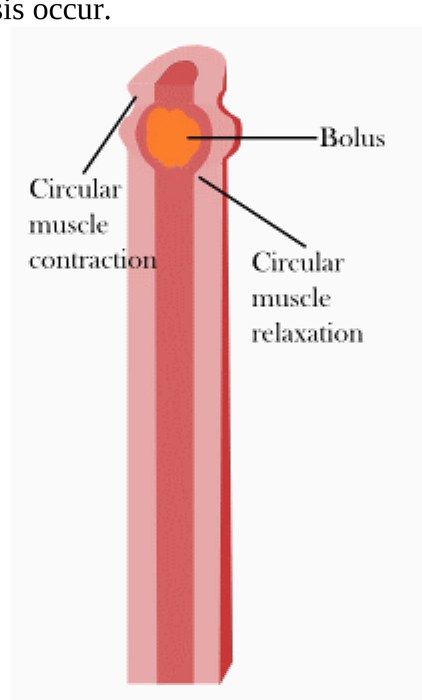
Physical digestion is the breaking down of food into small particles without the use of any chemicals such as digestive enzymes. Physical digestion occurs in the mouth (the chewing of food by the teeth and tongue), and the stomach (the continual contractions and relaxations of the stomach muscles causes a churning action, breaking down the food particles and mixing them with digestive enzymes). Physical digestion helps with chemical digestion as it provides a larger surface area for the digestive enzymes to work on, thus speeding up the digestion process. It can also be called "mechanical digestion".

Peristalsis

Peristalsis is the contraction of muscles that propel food down the digestive tract. The word is derived from the Greek word *peristaltikos*, which means "to wrap around", and "to place".
In the gastrointestinal tract, smooth muscles contract in sequence to produce a peristaltic wave which forces a ball of food (called a bolus while in the esophagus and gastrointestinal tract and chyme in the stomach) along the gastrointestinal tract. Peristaltic movement is initiated by circular smooth muscles contracting behind the chewed material to prevent it from moving back into the mouth, followed by a contraction of longitudinal smooth muscles which pushes the digested food forward.

Peristalsis in the esophagus

In the esophagus, two types of peristalsis occur.



A simplified image showing peristalsis

- First, there is a **primary peristaltic wave**; once the bolus enters the esophagus during swallowing. The primary peristaltic wave forces the bolus down the esophagus and into the stomach in a wave lasting about 8–9 seconds. The wave travels down to the stomach even if the bolus of food descends at a greater rate than the wave itself, and will continue even if for some reason the bolus gets stuck further up the esophagus.
- In the event that the bolus gets stuck or moves slower than the primary peristaltic wave (as can happen when it is poorly lubricated), stretch receptors in the esophageal lining are stimulated and a local reflex response causes a **secondary peristaltic wave** around the bolus, forcing it further down the esophagus, and these secondary waves will continue indefinitely until the bolus enters the stomach.

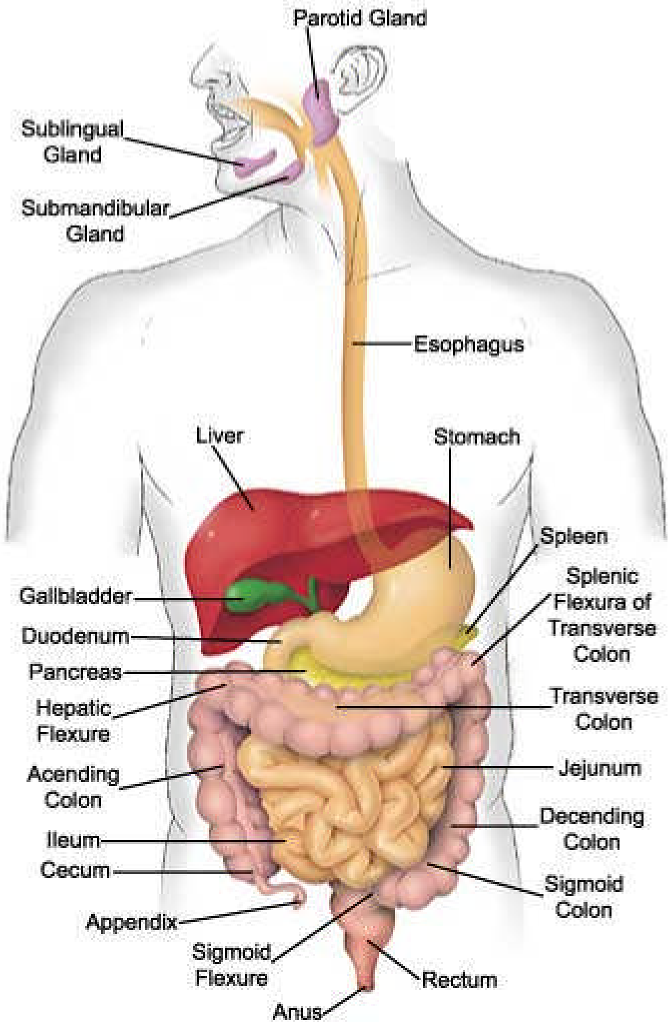
Peristalsis in the small intestine:
Once processed and digested by the stomach, the milky chyme is squeezed through the pyloric valve into the small intestine. Once past the stomach a typical peristaltic wave will only last for a few seconds, traveling at only a few centimeters per second. Its primary purpose is to mix the chyme in the intestine rather than to move it forward in the intestine. Through this process of mixing and continued digestion and absorption of nutrients, the chyme gradually works its way through the small intestine to the large intestine.[5]

Chemical Digestion

Chemical digestion is the breaking down of particles of food produced by physical digestion into smaller molecules of food which could be absorbed into the bloodstream. Unlike physical digestion, chemical digestion makes use of digestive enzymes. Chemical digestion takes place in the mouth (salivary amylase), stomach (proteases), and small intestines (amylases, proteases, and lipases).

The digestive enzymes include the following:

- Amylase: source is salivary glands in the mouth; substrate is starch; product is maltose; and optimum pH is about 7 (balanced). Amylase digests carbohydrates.
- Protease (a.k.a. pepsin): source is glands in stomach wall; substrate is proteins; product is polypeptides; optimum pH is 2 (acidic). Proteases digest proteins.
- Lipase: source is the pancreas; substrate is lipids; product is glycerol and fatty acids; optimum pH is basic (higher than 7). Lipases digest fats.



The stomach is where the protein digestion process begins. Pepsin breaks the proteins down into small polypeptides. The small intestine is the site where most of the breaking down of food occurs, and also where absorption of nutrients occurs. This is where fats begin to be broken down. Starch, glycogen, and smaller polysaccharides are hydrolyzed into disaccharides such as maltose. Maltose is split into two simpler molecules of maltase. The lining of the small intestine is made of small villi, which absorb small molecules, putting them in the circulatory system(sugars & peptides) or the lymphatic system(fats). In the large intestine water is reabsorbed and the wastes of the digestive tract, feces, are taken up. They become more solid by the removal of water, and then pass out of the rectum.
Absorption is the passage of digested substances through the wall of the intestine into the blood capillaries in bodies. Assimilation is a process by which food becomes incorporated within the body without being broken down. [6]

Metabolic Pathways

Metabolic pathways are the sequences of biochemical steps through which substances in living things change from one form to another. Each reaction in a metabolic pathway is dependent on a specific precursor: a chemical, an enzyme, or the transfer of energy. One of the first studies of metabolic pathways was carried out in 1909 by the British physician Archibald Garrod (1857-1936). His study suggested a link between the inability to make a particular enzyme and inherited disease. The disease was alkaptonuria, a condition in which urine darkens upon exposure to air, due to the presence of the chemical alkapton. Garrod's discovery was one of the first incidents of a physical manifestation being tied to a specific metabolic disorder. [7]

The human body contains chemical compounds, such as water, carbohydrates (sugar, starch, and fiber), amino acids (in proteins), fatty acids (in lipids), and nucleic acids (DNA and RNA). These compounds in turn consist of elements such as carbon, hydrogen, oxygen, nitrogen, phosphorus, calcium, iron, zinc, magnesium, manganese, and so on. All of these chemical compounds and elements occur in various forms and combinations.

The human body consists of elements and compounds ingested, digested, absorbed, and circulated through the bloodstream to feed the cells of the body. Except in the unborn fetus, the digestive system is the first system involved. In a typical adult, about seven liters of digestive juices enter the lumen of the digestive tract. These break chemical bonds in ingested molecules, and modulate their conformations and energy states. [8]

The Conversion of Digested Nutrients into Energy

Cellular Respiration

Cellular respiration begins with the raw materials glucose and oxygen and yields carbon dioxide and water (both waste products) and free energy, some of which is captured and stored in a usable form as ATP. The chemical equation for this conversion is $C_6H_{12}O_6 + 6\ O_2 \dashrightarrow 6\ CO_2 + 6\ H_2O$ + energy (ATP).

The foundation of the process is glucose, a simple sugar molecule made up of 6 atoms each of carbon and oxygen and 12 atoms of hydrogen. Glucose can be found in varying amounts in the carbohydrates, fats, and proteins that we consume.

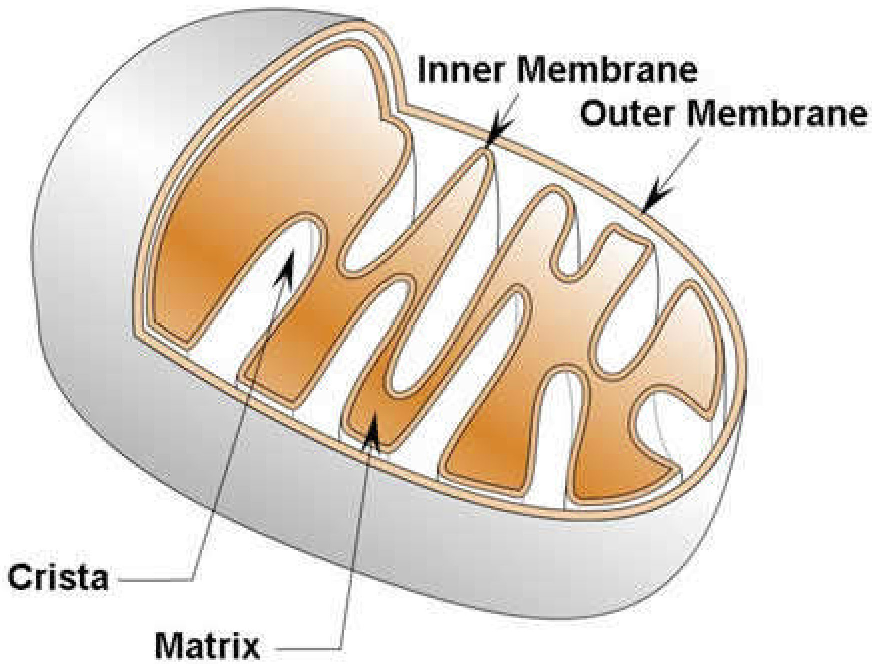
The food we eat must be broken down before it ever enters the cell's mitochondria, where cellular respiration takes place. Breaking down complex carbohydrates into glucose is a relatively simple process. Complex carbohydrate molecules are made up primarily of multiple glucose molecules linked together. Enzymes in the stomach and intestines separate individual glucose molecules from one another early in the digestive process. In contrast, fats and amino acids, the molecules that make up proteins, have chemical structures that only vaguely resemble glucose. They contain carbon, hydrogen, and oxygen atoms, just like glucose, but in dramatically different ratios.

The liver is responsible for converting carbohydrate, protein and fat molecules into glucose. It is also the place where excess carbohydrates are converted into a readily available but storable carbohydrate molecule called glycogen and into fat. The direction of these conversions depends on the level of glucose in the blood. When the concentration of glucose in the blood is low, the liver converts glycogen and fat (and in their absence, protein) into glucose. When blood glucose levels are high, the liver reverses the process, storing carbohydrates and maintaining fat and protein stores.

Cells obtain glucose from the blood, through the walls of capillaries nearby. These capillaries carry not only glucose but also oxygen and many other important nutrients. Once inside the cell glucose is absorbed by organelles called mitochondria. These important structures play host to the two stages of cellular respiration: the Krebs cycle and the electron transport chain. Combined, these chemical conversions and the raw material glucose that feeds them, produce the energy that drives nearly every cellular process in your body. [9]

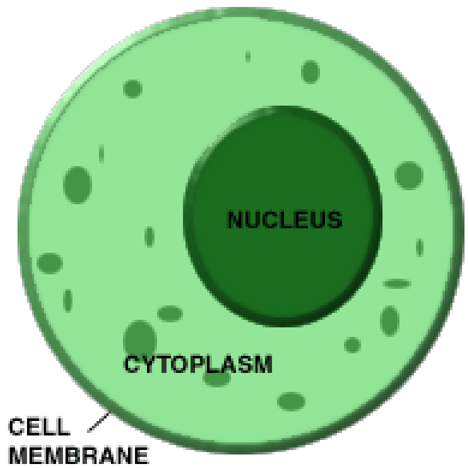
Components of Cellular Respiration:

Mitochondria- The mitochondria is an organelle found in human cells. The mitochondria is said to be the power house of the cell and creates almost all of the ATP (adenosine tri-phosphate which is made up of adenosine and three phosphates) required for the daily functions of the cell. Cells that would require more energy like muscle cells, would have a larger amount of mitochondria.



A single cell can contain several thousand mitochondria, and cells with especially high energy demands generally have the largest number of mitochondria.

Cytoplasm- The cytoplasm is a gelatin like substance found in all cells. The cytoplasm is the site of many chemical reactions. The sum all of these chemical reactions is called metabolism. The cytoplasm is made up of about 70 percent water and 30 percent proteins, carbohydrates, ions, fats, and nucleic acids. The cytoplasm houses all of the organelles inside of the cells.



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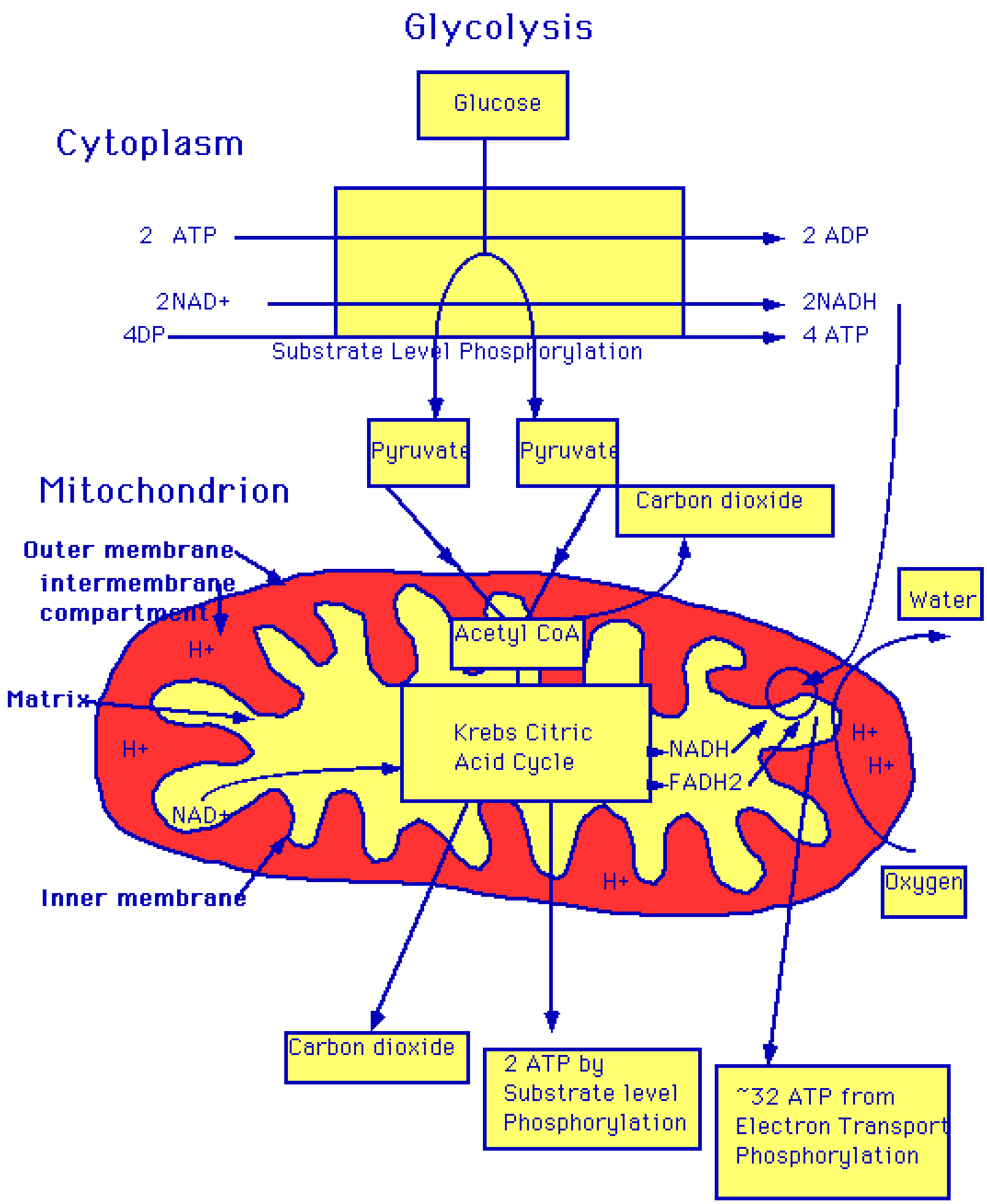
Three Stages of Cellular Respiration

The three stages of cellular respiration include glycolysis, the Krebs Cycle and the electron transport system.



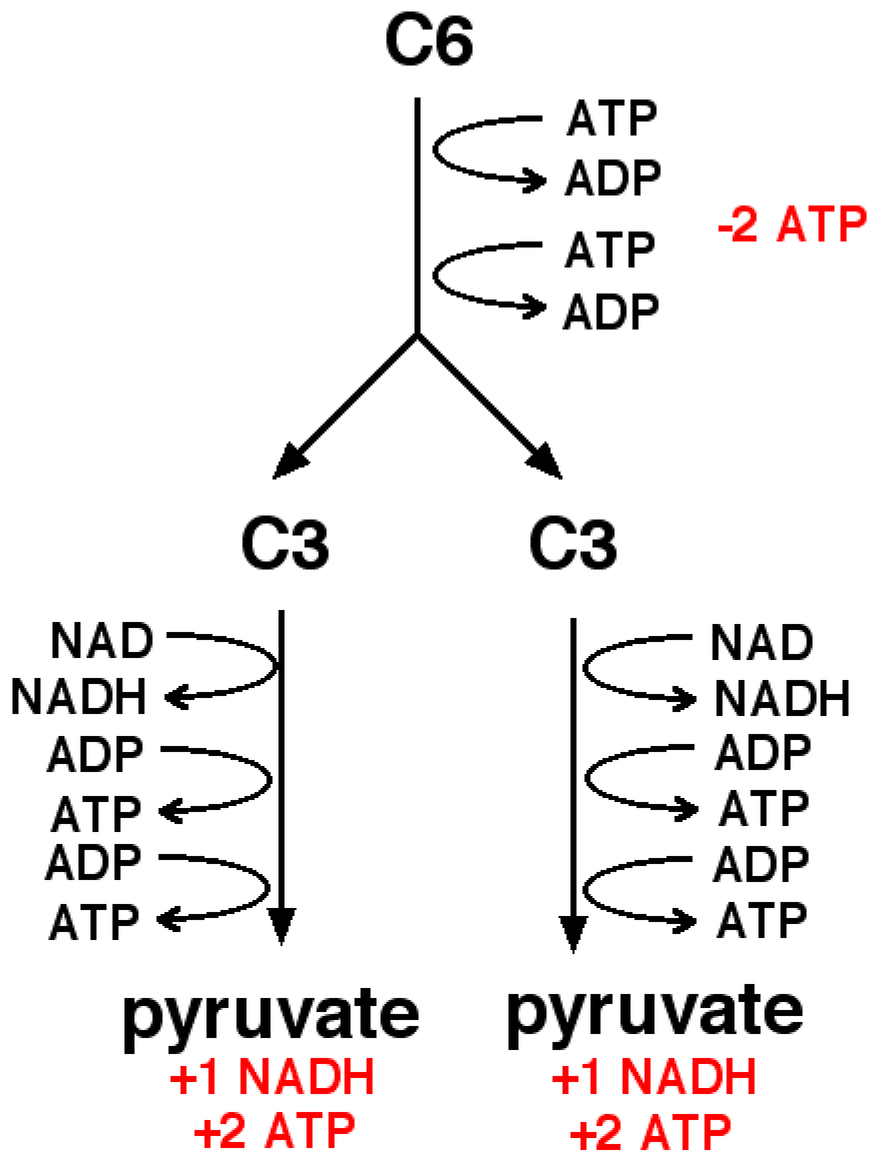
Glycolysis is the first stage of cellular respiration which begins in the cytoplasm of a cell, when a glucose molecule is split into two negatively- charged ions of *pyruvate*. G*lycolysis*, does not require oxygen and is a form of anaerobic respiration. The energy released during glycolysis is used by the cell to generate 2 ATP molecules by adding a single phosphate group to each of 2 ADP molecules.

The splitting of glucose during glycolysis also produces high-energy hydrogen ions (H^+). A pyruvate ($C_3H_3O_3^-$) ion is negatively-charged because it is missing a hydrogen ion, and so it has an extra electron that isn't paired with a proton. The uncharged hydrogen atoms that are liberated when glucose is split into pyruvate ultimately combine with oxygen to form water molecules.

The highly energetic H^+ ions would do damage if they were left unpaired. They are gotten rid of by combining them with the coenzyme *NAD* (**N**icotinamide **A**denine **D**inucleotide), to form NADH. Therefore, glycolysis produces 2 molecules of ATP that store and transport energy, plus two molecules of NADH, which get rid of the energetic and therefore potentially dangerous H^+ ions.

Of course, the fact that the H^+ ions are so energetic means that it is possible to extract energy from them, and the cell does exactly that. Energy stored in the NADH molecules is used to generate an additional 4 molecules of ATP. (Cardiac muscle cells and liver cells are more efficient at this, and can generate not 4 but *6* ATP molecules in this way.)

At the end of this first stage in cellular respiration, the cell will typically have generated a total of 6 molecules of ATP from the splitting of a glucose molecule – 2 ATP molecules from glycolysis and 4 more from processing of electrons temporarily stored in molecules of NADH. If the 2 pyruvates produced by the splitting of the original glucose molecule are to be broken down any further, however, oxygen is required. Otherwise, the pyruvate is processed into less-dangerous substances and excreted.



Complete breakdown of pyruvate into CO_2 and H_2O can only take place inside the mitochondria, so after glycolysis has been completed, the pyruvate is normally transported into mitochondria for further breakdown. A few cells in the body lack mitochondria (notably, red blood cells), and therefore they are capable *only* of anaerobic respiration. This would account for the short life span of RBCs.

During heavy exercise, skeletal muscle cells can find themselves in an anaerobic condition, because their metabolic rates are so high that they use up all the oxygen that can be delivered to them by the blood. They can survive and continue to function for a time by producing energy through glycolysis. Because the end-products of glycolysis are poisonous to cells, there is a sharp limit to how long skeletal muscles can function anaerobically. One of the major effects of repeated exercise is that the circulatory system becomes more efficient at delivering oxygen to skeletal muscles, and so they can function for longer periods of time before running out of oxygen.

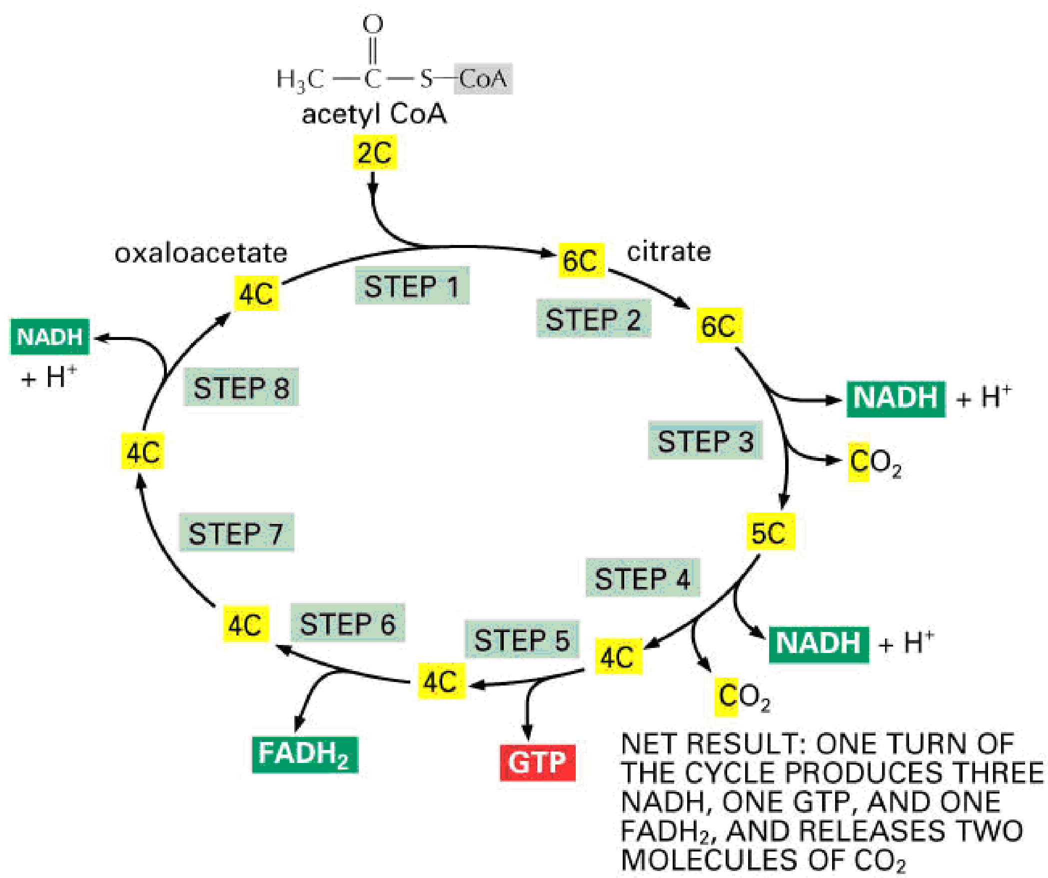
The TCA/Krebs/Citric Acid Cycle

The second stage of cellular respiration is the TCA/ Krebs/Citric Acid Cycle. When oxygen is available, the 2 pyruvate ions produced during glycolysis are transported into a mitochondrion. Inside the mitochondrion, the pyruvates are completely broken down in the TCA Cycle (the Tricarboxylic Acid Cycle), also known as the Krebs Cycle(named after the chemist, Hans Krebs), or the Citric Acid Cycle. This Cycle produces 2 more ATP molecules, plus 8 NADH and 2 FADH2 molecules. (FADH2, or flavin adenine dinucleotide, like NADH is a coenzyme.)

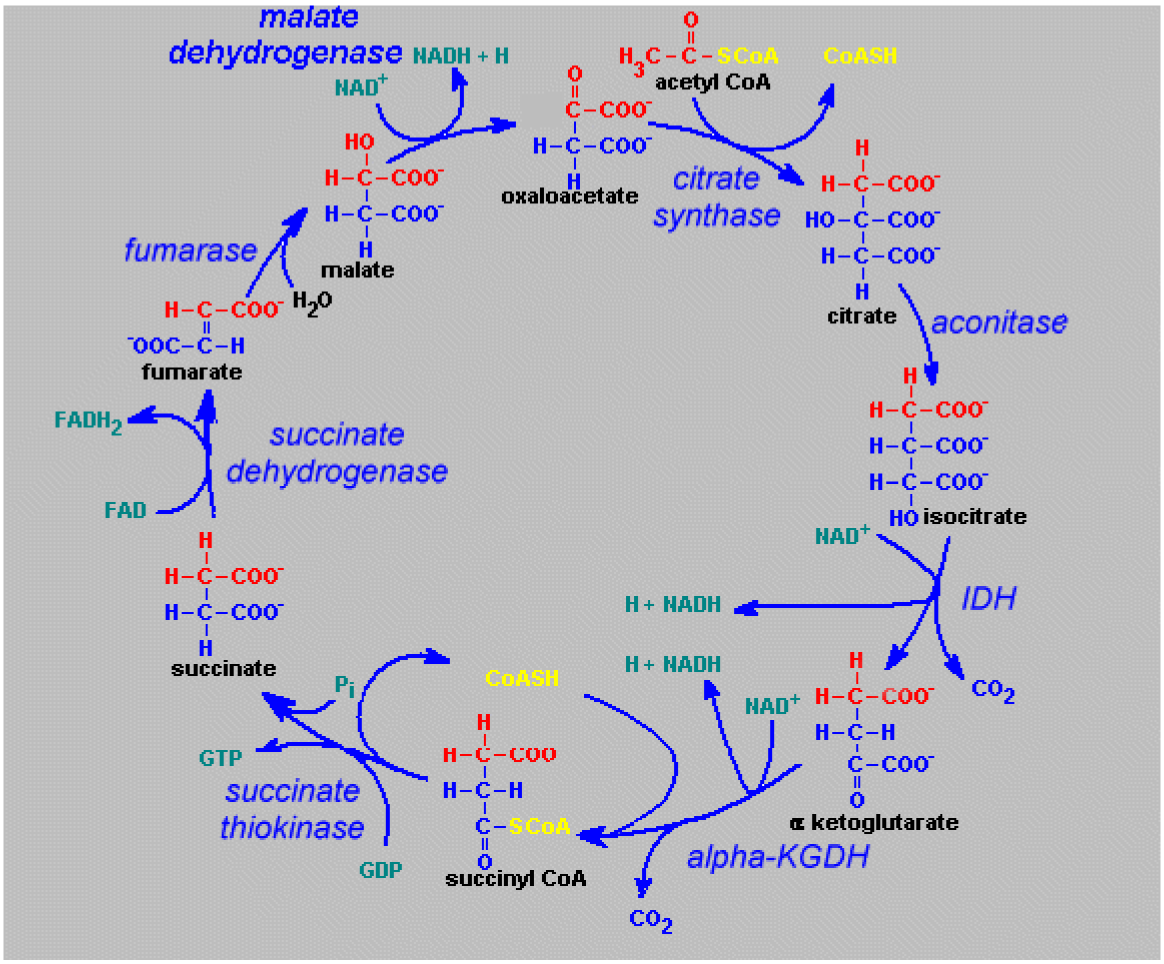
The Krebs cycle is the key to turning food into energy. During the Krebs Cycle acetlyl co-A (manufactured from glucose) and oxaloacetate form citric acid (aka citrate), which is very high in energy.

The citric acid gradually loses that energy, partly as CO2 (a waste product) and partly as GTP and NADH and FADH2, which go on to produce ATP, which is used to power many of the actual operations in the body.

The remaining bits are then used to reconstruct the oxaloacetate molecule, waiting to get another acetyl co-A to begin the whole cycle over again. The following is simplified diagram:



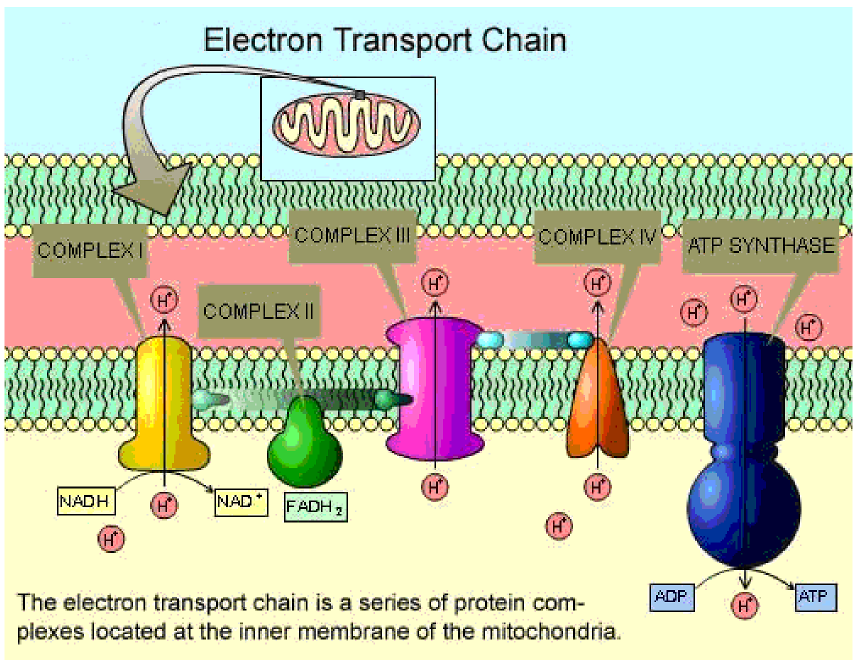
The acetyl co-A can also come from fats and proteins as well as carbohydrates, which is why this cycle is so important: every calorie you take in is transformed via this cycle into something you can use to power your body.



The TCA/Krebs/Citric Acid Cycle begins when a 2-carbon acetyl-CoA molecule binds to a 4-carbon oxaloacetate molecule to form a 6-carbon molecule of citrate (citric acid). Two of the carbon atoms are stripped off the citrate, one at a time, and combined with oxygen to form CO_2, which is excreted. Ultimately, the stripping of 2 carbons from citrate regenerates oxaloacetate, which can then combine with another molecule of acetyl-CoA.

The Electron Transport System

The electron transport system is composed of four enzymes (Complexes I, II, III, and IV). These enzymes are all located in the inner mitochondrial membrane.



Complex I: NADH Dehydrogenase: Complex I is responsible for removing two electrons from NADH and transferring them to the electron carrier, ubiquinone (Q). The reduced product is called ubiquinol (QH_2) and can freely move about the membrane. NADH dehydrogenase also moves four protons from the mitochondrial matrix to the intermembrane space, beginning the production of a proton gradient.

Complex II: Succinate Dehydrogenase: Complex II removes electrons from succinate and transfers them to ubiquinone via FAD. Succinate dehydrogenase does not contribute to the proton gradient.

Complex III: Cytochrome bc$_1$ Complex: Complex III removes two electrons form QH_2 and transfers them to two molecules of the electron carrier, cytochrome c. The cytochrome bc$_1$ complex also moves four protons across the inner mitochondrial membrane, further contributing to the proton gradient.

Complex IV: Cytochrome c Oxidase: Complex IV removes two electrons from the two molecules of cytochrome c and transfers them to molecular oxygen (O_2), producing water. Cytochrome c oxidase also moves two electrons across the inner mitochondrial membrane, adding to the proton gradient.

Electrons from NADH (Complex I) and $FADH_2$ (Complex II) are passed through the electron transport chain to oxygen (Complex IV), which is reduced to water. During electron transport, the enzymes of the electron transport chain create a proton gradient across the inner mitochondrial membrane. This proton gradient is subsequently used by the enzyme ATP synthase to produce ATP.[11]

The NADH and $FADH_2$ molecules feed the energetic electrons they've captured into *electron transport chains*, which strip energy from the electrons. Ultimately, the energetic electrons and H^+ ions are eliminated by combining them with oxygen to form water (H_2O). The *electron transport system* produces an additional 28 ATP molecules.

The Advantages of Aerobic Respiration:

Anaerobic respiration can produce only 2 molecules of ATP for each glucose molecule broken down. Additionally, it produces highly toxic waste products. Even under the best of conditions, anaerobic respiration produces only 6 molecules of ATP for each molecule of glucose consumed.

Aerobic respiration can produce up to 38 molecules of ATP for each molecule of glucose consumed and its waste products (water and carbon dioxide) are much less toxic.

Calories

The calorie is the unit for measuring the energy value of foods. A calorie is a measure of heat. One small calorie represents the amount of heat needed to raise the temperature of 1 gram of water 1 degree Celsius (called the gram calorie). A large calorie, or kilocalorie, is equal to 1000 small calories. It is the amount of heat needed to raise 1 kg of water (1 liter) 1 degree Celsius.

Fat has approximately 9 calories per gram while carbohydrates and proteins contain about 4 calories per gram. Therefore, to calculate the total caloric content of a food, multiply the number of grams of fat by 9, and each of the grams of carbohydrates and proteins by 4 and add the totals together. For example, if a food has 10 grams of fat, 10 grams of carbohydrate and 10 grams of protein, the total caloric content is 10x9 (fat) + 10x4 (carbohydrate) + 10x4 (protein) = 170 calories. It is necessary to consume 3500 calories to add 1 pound of body weight.

The Food and Nutrition Board of the National Research Council opined that the average caloric needs for a 19--50 year old male is 2900 calories per day or 17 calories per pound of body weight;2200 calories per day or 16 calories per pound of body fat for a 19--50 year old female.

Active people, such as athletes, require more calories than sedentary people. For example, a baseball pitcher expends 1440 calories per a typical nine inning game. A 200 lb athlete will require approximately 3000 calories to keep from losing or gaining weight in the off season. The same 200 lb athlete will require 3600 calories to fuel training.

An Athlete's Caloric Needs by Body Weight and Activity Level

Weight	Postseason (cal)	Off-season (cal)	Non starter	Starter
150	2,100	2,550	3,000	3,450
160	2,240	2,720	3,200	3,680
170	2,380	2,890	3,400	3,910
180	2,520	3,060	3,600	4,140
190	2,660	3,230	3,800	4,370
200	2,800	3,400	4,000	4,600
210	2,949	3,570	4,200	4,830
220	3,080	3,740	4,400	5,060
230	3,220	3,910	4,600	5,290
240	3,360	4,080	4,800	5,520

How Many Calories Are Needed To Gain One Pound Of Muscle?

It is necessary to consume 3500 Calories to add one pound of body weight, provided that all other variables remain the same. A muscle fiber is composed of approximately 70% water, 7% lipids and 22% tissue. Therefore, one pound of muscle tissue (454 grams) would contain about 100 grams of protein (454g x .22 = 100 g of protein). In theory, 450 protein calories would produce the desired one pound of muscle weight 100 g protein x 4.5 cals = 450 kcals protein). You would need 14 grams of protein daily to gain one pound of muscle in one week (14g protein x 7 days/wk = 100g protein).

To Gain Weight and Build Muscle

- Emphasize large muscle group exercises and progressive resistance training methodologies.
- Allow your weight gain to occur over a long period of time… One to two pounds per month.
- Maintain a quality diet that is low in fat.
- Exercise regularly so that the extra calories in your diet are not "wasted" and stored as fat.
- Perform aerobic exercise for total fitness.

Carbohydrates

Carbohydrates are basic foodstuffs formed when energy from the sun is harnessed in plants. They are organic compounds consisting of carbon, hydrogen and oxygen in various combinations. Carbohydrates are the body's preferred energy source, containing many vitamins and minerals. They are generally high in fiber and low in fat.

Carbohydrates come in two basic forms:

- **Simple carbohydrates**, known as sugars, are found naturally in foods such as fruits. Fruits are a monosaccharide (one molecule sugar) commonly referred to as fructose. Disaccharides are combinations of two simple sugars to form a new compound (glucose + fructose = sucrose). Sucrose is table sugar.

- **Complex carbohydrates,** commonly known as starches, are multiple combinations of simple sugars (polysaccharides). Starches have more nutritional value than simple sugars because of their high vitamin and mineral content. Wheat, rice, corn, legumes (beans and peas), and vegetables are common starches. Carbohydrates should comprise approximately 60 percent of one's dietary intake.

Carbohydrates are digested and converted to glucose, a simple carbohydrate absorbed into the blood from the intestines. Blood glucose may be utilized directly by some tissues, such as the brain, for energy, or it can be stored in the liver or muscles as glycogen (a complex carbohydrate). Excess blood glucose may be excreted in the urine or converted into fat and stored in the body's adipose tissue.

Dietary fiber is the carbohydrate in plants that is resistant to digestive enzymes which leaves residue in the digestive tract enhancing the peristalsis process. Dietary fiber adds bulk to the contents of the large intestine thereby diluting any possible cancer causing agents that might attack cell walls. Fiber may bind with carcinogens so that they are excreted by the bowel. Fiber also may bind with and lead to the excretion of bile salts which contain cholesterol. Additionally, fiber slows down gastric emptying and glucose absorption which helps to regulate blood sugar thereby lengthening the sensation of fullness or satiety, which is important to people on weight loss diets. Increasing the intake of complex carbohydrates will lead to an increase in dietary fiber. Dietary fibers can be either water--soluble (gums and pectins) or water--insoluble (cellulose, hemicellulose). Bran cereal is high in fiber, containing 5--13 grams of fiber per ounce.

Sports performance, to a large extent, depends upon the amount of glycogen which is stored in the muscles before and during exercise or the athletic event. Consequently, the athlete should make sure that 60 to 70% of their total calories comes from carbohydrates.

Fat

Fat is the most concentrated form of food energy, containing approximately twice as many calories as carbohydrates or proteins. 20 to 30% of an athlete's total calories should come from fat. Fat allows the baseball player to last for nine innings; the basketball player to play 60 minutes; and the boxer to box for 12 rounds. Fat calorie intake should be equally distributed among saturated, monounsaturated and polyunsaturated fats.

Dietary fats are also known as lipids. The two major dietary lipids are triglycerides and cholesterol.

Triglycerides--are composed of two different compounds--glycerol and fatty acids.

Glycerol--is an alcohol (clear, colorless syrupy liquid).

Fatty acids--are chains of carbon and hydrogen atoms that vary in the degree of hydrogen saturation. A **saturated fatty acid** has a full quota of hydrogen atoms. **Monounsaturated fatty acids** are capable of absorbing two or more hydrogen ions. **Polyunsaturated fatty acids** are capable of absorbing four or more hydrogen ions. Most saturated fats come from animal sources and tend to be solid at room temperature. Conversely, unsaturated fats come from plant sources and are liquid at room temperature. Sources of saturated fat include beef, pork, eggs and dairy products. Monounsaturated fats include chicken, olive oil, canola oil peanuts. Polyunsaturated fats include fish, safflower, soybean and sunflower oil.

Hydrogenated fats or oils are treated by a process that adds hydrogen to some of the unfulfilled bonds which hardens the fat or oil. These fats are called trans fatty acids.

Essential Fatty Acids--are fats or oils which are polyunsaturated. Essential fatty acids are grouped into two families; **omega--6** and **omega--3 fatty acids.** Although both types of essential fatty acids are needed, an excess of omega--6s can promote inflammation, tumor growth and blood clotting. The main sources of omega--6 fatty acids are vegetable oils, such as corn oil and soy oil, which contain a large amount of linoleic acid. Omega--3 fatty acids are found in flaxseed oil, walnut oil and fatty fish. The main component of flaxseed and walnut oils is alpha--linolenic acid while the predominant fatty acids found in fatty fish (salmon, mackerel and sardines) are eicosapentaenoic acid (E P A) and docosahexaenoic acid (D H A). In the early 1970's scientists observed that Greenland Eskimos had an exceptionally low incidence of heart disease and arthritis even though they consumed a high fat diet. Research discovered the Eskimos consumed large quantities of EPA and DHA omega--3 fatty acids. Fish oils, EPA and DHA, help to prevent atherosclerosis, heart attack, depression, cancer, rheumatoid arthritis, diabetes and ulcerative colitis. The recommended daily intake of EPA and DHA is 650mg.

Medical literature suggests that fish oils prevent and may help to reverse atherosclerosis, angina, heart attack, congestive heart failure, arrhythmias, stroke and peripheral vascular disease. Fish oils help to prevent blood clotting, reduce blood pressure, stabilize heart rhythm and maintain artery wall elasticity.

International Health News Findings

- Researchers at the University of Cincinnati have found that supplementing with as little as 2 grams/day of fish oil (410 mg of EPA plus 285 mg of DHA) can lower diastolic pressure by 4.4 mm Hg and systolic pressure by 6.5 mm Hg in people with elevated blood pressure.

- Daily supplementation with as little as 2.7 grams of EPA and 1.8 grams of DHA can markedly reduce the number of tender joints and increase the time before fatigue sets in.

- The human brain is one of the largest "consumers" of DHA. A normal adult human brain contains more than 20 grams of DHA. Low DHA levels have been linked to low brain serotonin levels which are connected to an increased tendency for depression, suicide, and violence. A high intake of fish has been linked to a significant decrease in age-related memory loss and cognitive function impairment, and a lower risk of developing Alzheimer's disease.

- There is considerable evidence that fish oil consumption can delay or reduce tumor development in breast cancer. Studies have also shown that a high blood level of omega-3 fatty acids combined with a low level of omega-6 fatty acids reduces the risk of developing breast cancer. Daily supplementation with as little as 2.5 grams of fish oils has been found effective in preventing the progression from benign polyps to colon cancer and researchers in Korea recently reported that prostate cancer patients have low blood levels of omega-3 fatty acids.

- Danish researchers have concluded that fish oil supplementation may help prevent arrhythmias and sudden cardiac death in healthy men. An Italian study of 11,000 heart attack survivors found that patients supplementing with fish oils markedly reduced their risk of another heart attack, a stroke or death. A group of German researchers found that fish oil supplementation for 2 years caused regression of atherosclerotic deposits and American medical researchers report that men who consume fish once or more every week have a 50% lower risk of dying from a sudden cardiac event than do men who eat fish less than once a month.

Recommended Intake of Fatty Acids

Fatty Acid	Type of Fat	Recommended Intake	
		Grams	**% of Calories**
DHA plus EPA combined. Oil from cold water fish such as salmon, trout, mackerel and sardines.	Omega-3	0.65 g	0.3%
DHA (docosahexaenoic acid) To be at least………………………. Pregnant and lactating women………	Omega-3 ………………………………..	 0.22 g 0.30 g	 0.1%
EPA (eicosapentaenoic acid) To be at least…………………………	Omega-3 ……………..	 0.22 g	 0.1%
Alpha linolenic acid (LNA) Oil from flax seeds (50%), walnuts and green leafy vegetables. LNA can be converted to EPA and DHA in the body; however, the enzyme responsible for this conversion becomes less active with age as well as in a number of disease conditions such as hypertension and diabetes.	Omega-3	2.22 g	1.0%
Linoleic acid (LA) Not to exceed………………………. Oil from corn, safflower, sunflower and soybeans.	Omega-6 ………………	4.44 g 6.67 g	< 3.0%
Trans fatty acids Not to exceed……………………….. Hydrogenated or partially hydrogenated vegetable oils found in many margarines and baked goods. It is recommended to keep intake at a minimum.	NA …………….	 2 g	 < 1.0%
Saturated fatty acids Not to exceed……………………… Fats that are solid a room temperature such as beef, pork and butter.	NA ………………	 …………….	 < 8.0%
Monounsaturated fatty acids It is recommended that a majority of fatty acids should come from monounsaturates found abundantly in olive oil and canola oil.	Omega-9		

Cholesterol

Cholesterol is a fat--like, pearly substance that is an essential component in the formation of cell membranes and several hormones. Cholesterol can be obtained from one's diet. It is found only in animal food products and not in fruits, vegetables, nuts, grains or other plant sources. Cholesterol, is also naturally found in the body, manufactured primarily by the liver and to a lesser extent by the kidneys. Cholesterol is most common in the blood, brain tissue, liver, kidneys and fatty covers around nerve fibers. It helps to absorb and move fatty acids, and is necessary in the production of vitamin D on the surface of the skin.

Metabolic Breakdown and Use of Dietary Fat

Dietary fat is digested into fatty acids, glycerol and cholesterol and ultimately used for energy, utilized to form cell structures or stored as fat. Since lipids are insoluble in water, the liver constantly makes compounds called lipoproteins (lipids covered by a protein coat). The protein portion of the compound is called an apoprotein which allows the lipid to be transported in the blood.

Lipoproteins contain a core of triglycerides and cholesterol esters surrounded by a coat of apoproteins, cholesterol and phospholipids.

Four Types of Lipoprotein

1. **Chylomicron** (85% triglcerides; 9% phospholipids; 4% cholesterol; 2% protein). After digestion, fats are carried in the blood as chylomicrons.
2. **Very low-density lipoproteins (VLDL)** consist of 50% triglycerids; 20% cholesterol. 20% phospholipids + 10% protein. This lipoprotein delivers fatty acids and glycerol to the tissues.
3. **Low-density lipoproteins**. **LDL** contain 45% cholesterol. Increased levels of LDL, particularly if oxidized or modified, are associated with increased risk for coronary heart disease. LDL are often referred to as the bad cholesterol, for high levels are believed to contribute to the development of heart disease.
4. **HDL high density lipoproteins. HDL** contain 55 percent protein and moderate amounts of cholesterol. Several subclasses of HDL have been identified, such as HDL_2 and HDL_3. Higher levels of HDL, particularly the HDL_2 component, have been associated with a lessened risk of coronary heart disease. HDL are often referred to as the good cholesterol, for it is believed that they reduce the risk of heart disease.

Health Implications of Dietary Fat and Cholesterol

The average American consumes about 40 percent of their dietary Calories from fat (16 percent from saturated fat) and more cholesterol than is needed (between 400-600 milligrams per day). High levels of LDL and low levels of HDL increase the risk of disease. To promote health reduce the total amount of fat in the diet to less than 30 percent of caloric intake, strike a balance in the ratio of saturated, monounsaturated, and polyunsaturated fats to approximately 10 percent of the Calories from each, and reduce cholesterol intake to less than 300 milligrams per day, or possibly less than 100 milligrams per 1,000 Calories consumed. Polyunsaturated fats may help decrease total cholesterol, but they also appear to decrease the HDL component. Monounsaturated fats help lower total cholesterol, but, unlike polyunsaturated fats, they have little effect on HDL levels.

Protein

Protein is a complex chemical structure containing carbon, hydrogen, oxygen, and nitrogen. These four elements are combined into a number of different structures called **amino acids.** There are twenty amino acids, all of which can be combined together in a variety of ways to form the different proteins necessary for human body structure and function. Protein is one of our most essential nutrients, for it is the main structural component of all tissues in the body. Since all enzymes are derived from protein, all physiological processes are dependent upon this nutrient.

Protein is contained in foods from both animal and plant sources. Humans obtain their supply of amino acids from these two sources. The human body cannot synthesize all amino acids. The amino acids that cannot be manufactured in the body are called essential **amino acids;** they must be supplied in the diet. It should be noted that all twenty amino acids are necessary and must be present simultaneously for optimal maintenance of body growth and function. The term *essential* in relation to amino acids is used to distinguish those amino acids that must be obtained in the diet. The nonessential amino acids are formed in the body.

The proteins we ingest from animal products are superior to those found in plants. Animal protein is called a high-quality protein, whereas plant protein is called a low-quality protein.
Animal protein contains all the essential amino acids, it is a complete protein. Second, it contains the essential amino acids in the proper proportion. All amino acids must be present simultaneously in order for the body to synthesize them into necessary body proteins. If one essential amino acid is in short supply, protein production may be blocked. Excellent low-fat sources of protein include skim milk, turkey, and fish.

Generally, proteins exist in smaller concentrations in plants and may be lower in several of the essential amino acids. Most plant foods are unable to meet our total nutritional protein needs. However, if plant foods are eaten in proper combinations, they can provide a balanced supply of amino acids. Navy beans and rice are plant foods considered to be complete proteins.

The average male needs about *56* grams of protein per day, while the average female needs about 44 grams. (To calculate a patient's protein needs, multiply their body weight, in pounds, by 0.36 grams.)

Protein Utilization

After protein is digested, the amino acids are generally utilized to form body tissues and other protein substances, such as enzymes and hormones. Excess protein may be converted to glucose or fatty acids, and protein waste products may be excreted as urea.

Protein, unlike fats and carbohydrates, contains nitrogen in its molecular structure. In order to utilize amino acids as fuel, this nitrogen must be eliminated from your body. This elimination can be measured in body wastes such as urine and sweat. When your body uses more protein for energy than is being consumed, you are in negative nitrogen balance. Conversely, if you are consuming more protein than what is being used for energy, you are in positive nitrogen balance. For athletes, 1.0 grams of protein per kilogram of body weight per day may be insufficient for nitrogen balance.

The Myth of Protein Supplementation

Patients often ask if protein supplements are necessary for muscular size and strength gains while in a weight training program…

The answer is no…By gaining muscle mass, you will ultimately increase your body weight. To accomplish this, your weight training program must be accompanied by a gradual increase in Caloric in-take. These additional kilocalories, from larger or more frequent meals and snacks, will usually provide you with the extra protein needed to reach your goals. The percentage of protein in your diet should remain the same (approximately 15%

of total Calories). Many of the protein supplement products are not comprised of complete proteins and consequently represent a bad investment.

The 20 Dietary Amino Acids

Essential	Non-Essential
Histidine(children)	Alanine
Isoleucine	Arginine
Leucine	Asparagine
Lysine	Aspartic Acid
Methoionine	Cysteine
Phenylalanine	Glutamic Acid
Threonine	Glutamine
Trptophan	Glycine
Valine	Proline
	Serine
	Tyrosine

Associated Risks of Excess Protein Consumption:

- Anorexia
- Dehydration
- Diarrhea
- Impaired kidney function
- Impaired substrate utilization
- Liver damage

Dietary Protein Health Implications

The body cannot store excess protein for use in times of a deficiency; therefore, daily protein intake is important. The prudent clinician should inform patients on extremely low calorie diets that they may not be ingesting sufficient protein and consequently may experience a loss of protein tissue such as muscle.

Animal protein is typically has substantial amounts of saturated fat and cholesterol, both of which are associated with several health problems. To reduce the intake of fat while maintaining adequate protein intake, you need to be selective in your choice of foods. For example, a glass of whole milk and a glass of skim milk both have about 8 grams of protein, but whole milk has 8 grams of fat compared to only 1 gram or less of fat in the skim milk. Drinking a glass of skim milk instead of whole milk reduces your fat intake by 7 grams and saves you about 60 Calories.

Vitamins

Vitamins, found in small amounts in most foods, represent a class of complex organic compounds that are essential for the optimal functioning of a great number of physiological processes. Some vitamins, particularly the B vitamins, function as coenzymes; they are needed to activate or control the activity of enzymes, those protein compounds that regulate almost all physiological processes in the body, such as digestion, muscle contraction, and the release of energy from foods. Some vitamins, such as C, E, and beta-carotene (a precursor of vitamin A) serve as antioxidants; they prevent undesired oxidative processes in the body. Vitamin D functions as a hormone.

Health Implications of Vitamins

The key to adequate vitamin nutrition is to consume a balanced diet of natural foods high in nutrient density. Epidemiological evidence has suggested that consumption of certain vegetables containing beta-carotene, such as carrots, sweet potatoes, and squash, and cruciferous vegetables, such as broccoli, cauliflower, cabbage, and brussel sprouts, may be helpful in the prevention of cancer. These foods contain sulforaphane (a natural anticarcinogen). Another hypothesis is that the antioxidant effect exerted by beta-carotene or other antioxidants naturally occurring in plants, such as phytic acid and vitamins C and E, may block the possible carcinogenic action of free radicals (especially reactive particles produced in the body that are thought to damage cell membranes) in the body on the cell membrane or DNA.

Megadoses of vitamins should be avoided. A megadose is defined as an amount which is ten times the RDA (lower for vitamin A [only 5 times] and vitamin D [only 2 times]). If the vitamin content of the body is adequate, excess vitamin intake does not serve any useful purpose and may function as a drug and be harmful to organs such as the liver. There are more than 4,000 cases of vitamin/mineral overdoses in the United States each year, resulting in about thirty fatalities, particularly among young children.

13 Essential Vitamins

Vitamin Name (Other Terms)	**RDA or ESADDI for Adults and Children over Four**	**Major Sources**
Fat-Soluble Vitamins		
Vitamin A (retinal; provitamin Carotenoids)	5000 IU or♂ 1,000 RE ♂ 4000 IU or 800 RE ♀	Retinol in animal foods; liver, whole milk, fortified milk, cheese, Carotenoids in plant foods; carrots, green leafy vegetables, sweet potatoes, fortified margarine from vegetable oils.
Vitamin D (calciferol)	400 IU or 10 micrograms	Vitamin D fortified foods like dairy products, margarine, and fish oils. Action of sunlight on the skin.
Vitamin E (tocopherol)	10 mg ♂ 8mg ♀ alpha-TE	Vegetable oils, margarine, green leafy vegetables, wheat germ, whole grain products, egg yolks.
Vitamin K (antihemorrhagic vitamin)	80 micrograms ♂ 65 micrograms ♀	Pork and beef liver, eggs, spinach, cauliflower. Formation in the human intestines by bacteria.
Water-Soluble Vitamins		
Thiamin (vitamin B_1)	1.5 mg ♂ 1.3 mg ♀	Ham, pork, lean meat, liver, whole grain products, fortified breads and cereals, legumes.
Riboflavin (vitamin B_2)	1.7 mg ♂ 1.3 mg ♀	Milk and dairy products, meat, fortified grain products, green leafy vegetables, beans.
Niacin (nicotinamide, nicotinic acid)	19 mg ♂15 mg ♀	Lean meats, fish, poultry, whole grain products, beans. May be formed in the body from tryptophan, an essential amino acid.
Vitamin B_6 (pyridoxal, pyridoxine, pyridoxamine)	2 mg ♂ 1.6 mg ♀	Protein foods, liver, lean meats, fish poultry, legumes, green leafy vegetables.
Vitamin B_{12} (cobalamin; cyanocobalamin)	2 micrograms	Animal foods only, meat, fish, poultry, milk, eggs.
Folic acid (folacin)	200 micrograms ♂ 180 micrograms ♀	Liver, green leafy vegetables, legumes, nuts.
Biotin	30-100 micrograms	Meats, legumes, milk, egg yolk, whole grain products, most vegetables.
Pantothenic acid	4-7 mg	Beef and pork liver, lean meats, milk, eggs, legumes, whole grain products, most vegetables.
Vitamin C (absorbic acid)	60 mg	Citrus fruits, green leafy vegetables, broccoli, peppers, strawberries, potatoes.

Vitamin	Major Functions in the Body	Deficiency Symptoms	Symptoms of Excess Consumption
Fat-Soluble Vitamins			
A	Maintenance of epithelial tissue in skin and mucous membranes, formation of visual purple for night vision, bone development.	Night blindness, intestinal infections, impaired growth, xeropthalmia.	Nausea, headache fatigue, liver and spleen damage, skin peeling, pain in the joints
D	Acts as a hormone to increase intestinal absorption of calcium and promote bone and tooth formation	Rare, Rickets in children and osteomalacia in adults.	Loss of appetite, nausea, irritability, joint pains, calcium deposits in soft tissues such as the kidney.
E	Functions as an antioxidant to protect cell membrances from destruction by oxidation.	Extremely rare, Disruption of red blood cell membranes, anemia.	General lack of toxicity with doses up to 600 IU.
K	Essential for blood coagulation processes.	Increased bleeding and hemorrhaging.	Possible clot formation (thrombus), vomiting.

Vitamin	Major Functions in the Body	Deficiency Symptoms	Symptoms of Excess Consumption
Water-Soluble Vitamins			
B1	Serves as a coenzyme for energy production from carbohydrate; essential for normal functioning of the central nervous system.	Poor appetite, apathy, mental depression, pain in calf muscles, beriberi.	General lack of toxicity.
B2	Functions as a coenzyme involved in energy production from carbohydrates and fats; maintains healthy skin.	Dermatitis, cracks at the corners of the mouth, sores on the tongue, damage to the cornea.	General lack of toxicity.
Niacin	Functions as a coenzyme for the aerobic and anaerobic production of energy from carbohydrate; helps synthesize fat needed for healthy skin.	Loss of appetite, weakness, skin lesions, gastrointestinal problems, pellagra.	Nicotinic acid causes headache, nausea, burning and itching skin, flushing of face..
B6	Functions as a coenzyme in protein metabolism; necessary for formation of hemoglobin and red blood cells; needed for glycogenolysis and gluconeogenesis.	Nervous irritability, convulsions, dermatitis, sores on tongue, anemia.	Loss of nerve sensation, impaired gait.
B12	Functions as a coenzyme for formation of DNA, development of RBC, and maintenance of nerve tissue.	Pernicious anemia, nerve damage resulting in paralysis.	General lack of toxicity.
Folic Acid	Functions as a coenzyme for DNA formation and RBC development.	Fatigue, gastrointestinal disorders, diarrhea, anemia.	May prevent detection of pernicious anemia caused by B12 deficiency.
Biotin	Functions as a coenzyme in the metabolism of carbohydrates, fats, and protein.	Rare. May be caused by excessive intake of raw egg whites. Fatigue, nausea, skin rashes.	General lack of toxicity.

Pantothenic Acid	Functions as part of coenzyme A in energy metabolism.	Rare. Only produced clinically Fatigue, nausea, loss of appetite, mental depression.	General lack of toxicity.
C	Forms collagen essential for connective tissue development; aids in absorption of iron; helps form epinephrine; serves as antioxidant.	Weakness, rough skin, slow wound healing, bleeding gums, scurvy.	Diarrhea, possible kidney stones, rebound scurvy.

Minerals

There are 106 known elements, 78 of them occurring naturally and the remainder man-made. A number of the natural elements are essential to human body structure and function.

Minerals are inorganic elements that are essential to life processes. Twenty-five minerals are known to be essential in human nutrition, and they perform a wide variety of functions in the body. Seven elements and minerals (carbon, oxygen, hydrogen, nitrogen, sulfur, calcium, and phosphorous, are used as building blocks for body tissues. Physiological processes influenced by minerals include muscle contraction, conduction of nerve impulses, acid - base balance of blood, blood clotting, and normal heart rhythm.

Mineral Health Implications

A deficiency or excess of any mineral may lead to serious health problems. Calcium, iron, and sodium are three minerals that appear to have significant health implications in the typical American diet.

Essential Minerals in Human Nutrition

Mineral (Symbol)	**Major Body Function**
Calcium (Ca)	Muscle contraction; nerve impulse transmission; blood clotting; fat digestion; formation of bone and teeth
Chlorine (Cl)	Water and electrolyte balance; formation of stomach acids
Chromium (Cr)	Glucose metabolism in cells; related to insulin action
Cobalt (Co)	Component of vitamin B_{12}; development of red blood cells
Copper (Cu)	Formation (with iron) of hemoglobin and iron enzymes
Fluorine (F)	Formation of bones and teeth
Iodine (I)	Formation of thyroxine (a thyroid hormone)
Iron (Fe)	Formation of compounds (such as hemoglobin) for the transportation of oxygen.
Magnesium (Mg)	Activates a number involved in the regulation of protein synthesis and muscle contraction.
Manganese (Mn)	Many enzyme functions; bone formation; fat synthesis

Molybdenum (Mo)	Required in several enzymes
Phosphorus (P)	Acts with calcium to form bone tissue; part of high-energy compounds in body cells
Potassium (K)	Maintains acid-base balance; nerve impulse conduction; muscle contraction; many other functions in the body cells
Selenium (Se)	Functions with vitamin E; liver function
Silicon (Si)	Formation of connective tissue
Sodium (Na)	Maintenance of normal body fluid volume; nerve impulse transmission and muscle contraction; acid-base balance
Sulfur (S)	Formation of body tissues and enzymes
Zinc (Zn)	Component of many enzymes

Calcium

Calcium intake among adults is often below the recommended level. Because calcium is the primary constituent of bone tissue, calcium deficiency, particularly in older women, may lead to osteoporosis**,** a decrease in bone mass that increases susceptibility to fractures in the hip, wrist, and spine. Foods high in calcium, such as dairy foods, should be consumed in the diet throughout life, particularly during the growth years to maximize bone mass.

Iron

National surveys suggest that over 90 percent of women are receiving less than the RDA for iron. Inadequate dietary intake or excessive losses of iron may lead to iron deficiency anemia**,** a condition that may lead to constant weakness and fatigue.

Sodium

A primary function of sodium is the maintenance of a normal blood pressure. Excessive intake of sodium has been linked with the development of high blood pressure in individuals who are salt or sodium sensitive. These individuals do not effectively regulate sodium balance. Since there may be 15 to 20 million Americans who may be sodium sensitive, it is recommended that the amount of sodium and salt in the diet be decreased.

General Overview of Mineral Consumption

Excessive intake of one mineral, usually through supplements, may impair the absorption of other essential minerals. For example, excessive intake of zinc will impair the absorption of copper. Many minerals may be toxic to the body if consumed in excess. It is very difficult to consume excessive amounts of minerals through natural foods, but mega doses provided by excessive intake of mineral supplements may seriously impair normal physiological functions. Excessive intake of potassium may disturb the normal electrical activity in the heart and may lead to arrhythmias and possible death. As with vitamins, mega doses of minerals, which may be only 3 to 5 times the RDA, are to be avoided.

Water

Most nutrients essential to life can be utilized by the human body only in their combination with water. Water provides the medium within which other nutrients may function and is the essential building material for cell protoplasm. It is the main transportation mechanism in the body, conveying oxygen, nutrients, hormones, and other compounds to the cells for their use. Water helps regulate acid-base balance and body temperature.

Body Water Requirements

The average adult male requires approximately 2800 milliliters of water per day to maintain adequate water balance in the body. Conversely, the average adult female requires approximately 2000 milliliters (2 liters or slightly more than 2 quarts) of water per day. Body water balance is maintained when the intake of water matches the output of body fluids.

Avenues of Daily Water Loss

Urinary output is the main avenue for water loss.
Water lost through insensible perspiration (perspiration which is not visible).
Water lost in feces.
Water lost through exhaled air during breathing.

Means of Water Intake

The main source of body water intake is due to the fluid intake of beverages.
Solid foods contain water. For example, foods such as lettuce, melons and other fruits contain about 90% water.
Fat, carbohydrate and protein metabolism all produce water when broken down into energy. This water is called metabolic water.

Several hormones and the sensation of thirst help maintain water balance on a day-to day basis. When exercising in the heat, body water losses can greatly exceed fluid intake. In such cases, several different heat illnesses may occur, such as heat exhaustion and heat stroke.

Daily Water Loss / Intake For the Adult Female

Water Loss

Source	Quantity
Urine output	1100 ml
Water in feces	100 ml
Lungs, exhaled air	200 ml
Skin, insensible perspiration	600 ml
Total	2000 ml

Water Intake

Source	Quantity
Fluids	1000 ml
Water in food	700 ml
Metabolic water	300 ml
Total	2000 ml

The Recommended Dietary Allowances (RDA)

The adequate, recommended amounts of certain nutrients have been established by the Food and Nutrition Board. The Recommended Dietary Allowances **(RDA)** are the levels of intake of essential nutrients considered in the judgment of the Food and Nutrition Board to be adequate to meet the known nutritional needs of practically all healthy persons in the United States. RDA have been established for energy intake (Calories), protein, eleven vitamins, and seven minerals.

Recommended Dietary Allowances For The Eight Key Nutrients

Nutrient	U.S RDA	Plant Source	Animal Source	Major Food Exchanges
Protein	56 g	Dried beans and peas, nuts	Meat, poultry, fish, cheese, milk	Meat, milk
Vitamin A	5000 IU	Dark green leafy vegetables, yellow vegetables, margarine	Butter, fortified milk, liver	Fruits, vegetables, fat
Vitamin C	60 mg	Citrus fruits, broccoli, potatoes, strawberries, tomatoes, cabbage, dark green leafy vegetables	Liver	Fruits, vegetables
Vitamin B_1 (thiamin)	1.5 mg	Breads, cereals, pasta, nuts	Pork, ham	Starch/Bread, meat
Vitamin B_2	.7 mg	Breads, cereals, pasta	Milk, cheese, liver	Starch/Bread, milk (riboflavin)
Niacin	20 mg	Breads, cereals, pasta, nuts	Meat, fish, poultry	Starch/Bread, meat
Iron	15 mg	Dried peas and beans, spinach, asparagus, prune juice	Meat, liver	Meat, starch/bread
Calcium	1000 mg	Turnip greens, okra, broccoli,	Milk, cheese, mackerel, salmon	Milk, vegetables spinach, kale

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Food Pyramid

Grains

What foods are in the grain group?

Any food made from wheat, rice, oats, cornmeal, barley or another cereal grain is a grain product. Bread, pasta, oatmeal, breakfast cereals, tortillas, and grits are examples of grain products.

Grains are divided into 2 subgroups, whole grains and refined grains.

Whole grains contain the entire grain kernel -- the bran, germ, and endosperm. Examples include:

- whole-wheat flour
- bulgur (cracked wheat)
- oatmeal
- whole cornmeal
- brown rice

Refined grains have been milled, a process that removes the bran and germ. This is done to give grains a finer texture and improve their shelf life, but it also removes dietary fiber, iron, and many B vitamins. Some examples of refined grain products are:

- white flour
- degermed cornmeal
- white bread
- white rice

Most refined grains are enriched. This means certain B vitamins (thiamin, riboflavin, niacin, folic acid) and iron are added back after processing. Fiber is not added back to enriched grains. Check the ingredient list on refined grain products to make sure that the word “enriched” is included in the grain name. Some food products are made from mixtures of whole grains and refined grains.

Some commonly eaten grain products are:

Whole grains:
brown rice
buckwheat
bulgur (cracked wheat)
oatmeal
popcorn

Ready-to-eat breakfast cereals:
whole wheat cereal flakes
muesli

whole grain barley
whole grain cornmeal
whole rye
whole wheat bread
whole wheat crackers
whole wheat pasta
whole wheat sandwich buns and rolls
whole wheat tortillas
wild rice

Less common whole grains:
amaranth
millet
quinoa
sorghum
triticale

Refined grains:
cornbread*
corn tortillas*
couscous*
crackers*
flour tortillas*
grits
noodles*

Pasta*
spaghetti
macaroni

pitas*
pretzels

Ready-to-eat breakfast cereals
corn flakes

white bread
white sandwich buns and rolls

How many grain foods are needed daily?

The amount of grains you need to eat depends on your age, sex, and level of physical activity. Recommended daily amounts are listed in the chart. Most Americans consume enough grains, but few are whole grains. At least ½ of all the grains eaten should be whole grains.

		Daily recommendation*	Daily minimum amount of whole grains
Children	2-3 years old	3 ounce equivalents**	1 ½ ounce equivalents**
	4-8 years old	4 – 5 ounce equivalents**	2 – 2 ½ ounce equivalents**
Girls	9-13 years old	5 ounce equivalents**	3 ounce equivalents**
	14-18 years old	6 ounce equivalents**	3 ounce equivalents**
Boys	9-13 years old	6 ounce equivalents**	3 ounce equivalents**
	14-18 years old	7 ounce equivalents**	3 ½ ounce equivalents**
Women	19-30 years old	6 ounce equivalents**	3 ounce equivalents**
	31-50 years old	6 ounce equivalents**	3 ounce equivalents**
	51+ years old	5 ounce equivalents**	3 ounce equivalents**
Men	19-30 years old	8 ounce equivalents**	4 ounce equivalents**
	31-50 years old	7 ounce equivalents**	3 ½ ounce equivalents**
	51+ years old	6 ounce equivalents**	3 ounce equivalents**

Vegetables

What foods are in the vegetable group?

Any vegetable or 100% vegetable juice counts as a member of the vegetable group. Vegetables may be raw or cooked; fresh, frozen, canned, or dried/dehydrated; and may be whole, cut-up, or mashed.

Vegetables are organized into 5 subgroups, based on their nutrient content. Some commonly eaten vegetables in each subgroup are:

Dark green vegetables
bok choy
broccoli
collard greens
dark green leafy lettuce
kale
mesclun
mustard greens
romaine lettuce
spinach
turnip greens
watercress

Orange vegetables
acorn squash
butternut squash
carrots
hubbard squash
pumpkin
sweet potatoes

Dry beans and peas
black beans
black-eyed peas
garbanzo beans (chickpeas)
kidney beans
lentils
lima beans (mature)
navy beans
pinto beans
soy beans
split peas
tofu (bean curd made from soybeans)
white beans

Starchy vegetables
corn
green peas
lima beans (green)
potatoes

Other vegetables
artichokes
asparagus
bean sprouts
beets
Brussels sprouts
cabbage
cauliflower
celery
cucumbers
eggplant
green beans
green or red peppers
iceberg (head) lettuce
mushrooms
okra
onions
parsnips
tomatoes
tomato juice
vegetable juice
turnips
wax beans
zucchini

How many vegetables are needed daily or weekly?

Vegetable choices should be selected from among the vegetable subgroups. It is not necessary to eat vegetables from each subgroup daily. However, over a week, try to consume the amounts listed from each subgroup as a way to reach your daily intake recommendation.

The amount of vegetables you need to eat depends on your age, sex, and level of physical activity. Recommended total daily amounts are shown in the first chart. Recommended weekly amounts from each vegetable subgroup are shown in the second chart.

Daily recommendation*		
Children	2-3 years old	1 cup**
	4-8 years old	1 ½ cups**
Girls	9-13 years old	2 cups**
	14-18 years old	2 ½ cups**
Boys	9-13 years old	2 ½ cups**
	14-18 years old	3 cups**
Women	19-30 years old	2 ½ cups**
	31-50 years old	2 ½ cups**
	51+ years old	2 cups**
Men	19-30 years old	3 cups**
	31-50 years old	3 cups**
	51+ years old	2 ½ cups**

Fruits

What foods are in the fruit group?

Any fruit or 100% fruit juice counts as part of the fruit group. Fruits may be fresh, canned, frozen, or dried, and may be whole, cut-up, or pureed. Some commonly eaten fruits are:

Apples
Apricots
Avocado
Bananas

Berries:
strawberries
blueberries
raspberries

Cherries
Grapefruit
Grapes
Kiwi fruit
Lemons
Limes
Mangoes

Melons:
cantaloupe
honeydew
watermelon

Mixed fruits:
fruit cocktail

Nectarines
Oranges
Peaches
Pears
Papaya
Pineapple
Plums
Prunes
Raisins
Tangerines

100% Fruit juice:
orange
apple
grape
grapefruit

How much fruit is needed daily?

The amount of fruit you need to eat depends on age, sex, and level of physical activity. Recommended daily amounts are shown in the chart.

Recommended amounts are shown in the table below.

Daily recommendation*		
Children	2-3 years old	1 cup**
	4-8 years old	1 to 1 ½ cups**
Girls	9-13 years old	1 ½ cups**
	14-18 years old	1 ½ cups**
Boys	9-13 years old	1 ½ cups**
	14-18 years old	2 cups**
Women	19-30 years old	2 cups**
	31-50 years old	1 ½ cups**
	51+ years old	1 ½ cups**
Men	19-30 years old	2 cups**
	31-50 years old	2 cups**
	51+ years old	2 cups**

Milk

What foods are included in the milk, yogurt, and cheese (milk) group?

All fluid milk products and many foods made from milk are considered part of this food group. Foods made from milk that retain their calcium content are part of the group, while foods made from milk that have little to no calcium, such as cream cheese, cream, and butter, are not. Most milk group choices should be fat-free or low-fat.

Some commonly eaten choices in the milk, yogurt, and cheese group are:

Milk*
All fluid milk:
fat-free (skim)
low fat (1%)
reduced fat (2%)
whole milk

flavored milks:
chocolate
strawberry

lactose reduced milks
lactose free milks

Milk-based desserts*
Puddings made with milk
ice milk
frozen yogurt
ice cream

Cheese*
Hard natural cheeses:
cheddar
mozzarella
Swiss
parmesan

soft cheeses
ricotta
cottage cheese

processed cheeses
American

Yogurt*
All yogurt
Fat-free
low fat
reduced fat
whole milk yogurt

How much food from the milk group is needed daily?

The amount of food from the Milk Group you need to eat depends on age. Recommended daily amounts are shown in the chart.

Daily recommendation		
Children	2-3 years old	2 cups*
	4-8 years old	2 cups*
Girls	9-13 years old	3 cups*
	14-18 years old	3 cups*
Boys	9-13 years old	3 cups*
	14-18 years old	3 cups*
Women	19-30 years old	3 cups*
	31-50 years old	3 cups*
	51+ years old	3 cups*
Men	19-30 years old	3 cups*
	31-50 years old	3 cups*
	51+ years old	3 cups*

Meat and Beans

What foods are included in the meat, poultry, fish, dry beans, eggs, and nuts (meat & beans) group?

All foods made from meat, poultry, fish, dry beans or peas, eggs, nuts, and seeds are considered part of this group. Dry beans and peas are part of this group as well as the vegetable group.

Most meat and poultry choices should be lean or low-fat. Fish, nuts, and seeds contain healthy oils, so choose these foods frequently instead of meat or poultry.
Some commonly eaten choices in the Meat and Beans group, with selection tips, are:

Meats*
Lean cuts of:
beef
ham
lamb
pork
veal

Game meats:
bison
rabbit
venison

Lean ground meats:
beef
pork
lamb

Lean luncheon meats
Organ meats:
liver
giblets
Poultry*
chicken
duck
goose
turkey
ground chicken and turkey
Eggs*
chicken eggs
duck eggs

Dry beans and peas:
black beans
black-eyed peas
chickpeas (garbanzo beans)
falafel
kidney beans
lentils
lima beans (mature)
navy beans
pinto beans
soy beans
split peas
tofu (bean curd made from soy beans)
white beans

bean burgers:
garden burgers
veggie burgers

tempeh
texturized vegetable protein (TVP)
Nuts & seeds*
almonds
cashews
hazelnuts (filberts)
mixed nuts
peanuts
peanut butter
pecans
pistachios
pumpkin seeds
sesame seeds
sunflower seeds
walnuts

Fish*
Finfish such as:
catfish
cod
flounder
haddock
halibut
herring
mackerel
pollock
porgy
salmon
sea bass
snapper
swordfish
trout
tuna

Shellfish such as:
clams
crab
crayfish
lobster
mussels
octopus
oysters
scallops
squid (calamari)
shrimp

Canned fish such as:
anchovies
clams
tuna
sardines

How much food from the meat & beans group is needed daily?

The amount of food from the Meat and Beans Group you need to eat depends on age, sex, and level of physical activity. Most Americans eat enough food from this group, but need to make leaner and more varied selections of these foods. Recommended daily amounts are shown in the chart.

Daily recommendation*		
Children	2-3 years old 4-8 years old	2 ounce equivalents** 3 – 4 ounce equivalents**
Girls	9-13 years old 14-18 years old	5 ounce equivalents** 5 ounce equivalents**
Boys	9-13 years old 14-18 years old	5 ounce equivalents** 6 ounce equivalents**
Women	19-30 years old 31-50 years old 51+ years old	5 ½ ounce equivalents** 5 ounce equivalents** 5 ounce equivalents**
Men	19-30 years old 31-50 years old 51+ years old	6 ½ ounce equivalents** 6 ounce equivalents** 5 ½ ounce equivalents**

Oils

What are "oils"?

Oils are fats that are liquid at room temperature, like the vegetable oils used in cooking. Oils come from many different plants and from fish. Some common oils are:

- canola oil
- corn oil
- cottonseed oil
- olive oil
- safflower oil
- soybean oil
- sunflower oil

Some oils are used mainly as flavorings, such as walnut oil and sesame oil. A number of foods are naturally high in oils, like:

- nuts
- olives
- some fish
- avocados

Foods that are mainly oil include mayonnaise, certain salad dressings, and soft (tub or squeeze) margarine with no trans fats.

Most oils are high in monounsaturated or polyunsaturated fats, and low in saturated fats. Oils from plant sources (vegetable and nut oils) do not contain any cholesterol. In fact, no foods from plants sources contain cholesterol.

A few plant oils, however, including coconut oil and palm kernel oil, are high in saturated fats and for nutritional purposes should be considered to be solid fats.

Solid fats are fats that are solid at room temperature, like butter and shortening. Solid fats come from many animal foods and can be made from vegetable oils through a process called hydrogenation. Some common solid fats are:

- butter
- beef fat (tallow, suet)
- chicken fat
- pork fat (lard)
- stick margarine
- shortening

How much is my allowance for oils?

Most Americans consume enough oil in the foods they eat, such as:

- nuts
- fish
- cooking oil
- salad dressings

A person's allowance for oils depends on age, sex, and level of physical activity. Daily allowances are shown in the chart.

Daily allowance*		
Children	2-3 years old 4-8 years old	3 teaspoons 4 teaspoons
Girls	9-13 years old 14-18 years old	5 teaspoons 5 teaspoons
Boys	9-13 years old 14-18 years old	5 teaspoons 6 teaspoons
Women	19-30 years old 31-50 years old 51+ years old	6 teaspoons 5 teaspoons 5 teaspoons
Men	19-30 years old 31-50 years old 51+ years old	7 teaspoons 6 teaspoons 6 teaspoons

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Dietary Guidelines for Americans

The *Dietary Guidelines for Americans* has been published jointly every 5 years since 1980 by the Department of Health and Human Services (HHS) and the Department of Agriculture (USDA). The Guidelines provide authoritative advice for people two years and older about how good dietary habits can promote health and reduce risk for major chronic diseases. They serve as the basis for Federal food and nutrition education programs.

Overview of Key Recommendations

Fats :

- Consume less than 10 percent of calories from saturated fatty acids and less than 300 mg/day of cholesterol, and keep *trans* fatty acid consumption as low as possible.
- Keep total fat intake between 20 to 35 percent of calories, with most fats coming from sources of polyunsaturated and monounsaturated fatty acids, such as fish, nuts, and vegetable oils.
- When selecting and preparing meat, poultry, dry beans, and milk or milk products, make choices that are lean, low-fat, or fat-free.
- Limit intake of fats and oils high in saturated and/or *trans* fatty acids, and choose products low in such fats and oils.

Recommendations for Specific Population Groups

Children and adolescents. Keep total fat intake between 30 to 35 percent of calories for children 2 to 3 years of age and between 25 to 35 percent of calories for children and adolescents 4 to 18 years of age, with most fats coming from sources of polyunsaturated and monounsaturated fatty acids, such as fish, nuts, and vegetable oils.

Carbohydrates:

It is recommended that carbohydrates constitute 45 to 65 percent of an individuals daily total calories. With respect to older adults, dietary fiber is important for laxation. Since constipation may affect up to 20 percent of people over 65 years of age, older adults should choose to consume foods rich in dietary fiber. Other causes of constipation among this age group may include drug interactions with laxation and lack of appropriate hydration.

Weight Management :

The prevalence of obesity in the United States has doubled in the past two decades. Nearly one-third of adults are obese, that is, they have a body mass index (BMI) of 30 or greater. Over the last two decades, the prevalence of overweight among children and adolescents has increased substantially; it is estimated that as many as 16 percent of children and adolescents are overweight, representing a doubling of the rate among children and tripling of the rate among adolescents. Excess body fat has been found to lead to a higher risk for premature death, type 2 diabetes, hypertension, cardiovascular disease, stroke, gall bladder disease, respiratory dysfunction, gout, osteoarthritis, and certain kinds of cancers.
For adults, a reduction of 50 to 100 calories per day may prevent gradual weight gain, whereas a reduction of 500 calories or more per day is a common initial goal in weight-loss programs. Similarly, up to 60 minutes of moderate- to vigorous-intensity physical activity per day may be needed to prevent weight gain, but as much as 60 to 90 minutes of moderate-intensity physical activity per day is recommended to sustain weight loss for previously overweight people.[14]

Physical Activity :

In 2002, 25 percent of adult Americans did not participate in any leisure time physical activities in the past month, [15] and in 2003, 38 percent of students in grades 9 to 12 viewed television 3 or more hours per day. [16] Physical activity is defined as any bodily movement produced by skeletal muscles resulting in energy expenditure[17] People with higher levels of physical fitness are also at lower risk of developing chronic disease. Mortality rates from all causes of death are lower in physically active people than in sedentary people. Also, physical activity can aid in managing mild to moderate depression and anxiety.

- To reduce the risk of chronic disease in adulthood: Engage in at least 30 minutes of moderate-intensity physical activity, above usual activity, at work or home on most days of the week.
- To help manage body weight and prevent gradual, unhealthy body weight gain in adulthood: Engage in approximately 60 minutes of moderate- to vigorous-intensity activity on most days of the week while not exceeding caloric intake requirements.

To sustain weight loss in adulthood: Participate in at least 60 to 90 minutes of daily moderate-intensity physical activity while not exceeding caloric intake requirements.[18]

Physicians Nutritional Recommendations To Patients

1. Maintain a healthy body weight. Consume only as many Calories, as you expend daily.

2. Eat foods rich in calcium and iron. One glass of skim milk provides about one-third the RDA for calcium. Vegetables, such as broccoli, are also good sources of calcium. Iron is found in good supply in the meat food group.

3. Eat a moderate amount of plant and animal proteins. The recommended dietary goal for protein is about 10-12 percent of the daily Calories. This averages out to about 50 to 60 grams of protein per day; the current American intake is about 100 grams. Unfortunately, most of the protein Americans eat is of animal origin. Animal products are an excellent source of complete protein, but they tend to be higher in saturated fats and

cholesterol compared to foods high in plant protein. Animal protein contains more iron and other minerals like zinc and copper than plant protein.

Four ounces of meat, fish, or poultry, combined with two glasses of skim milk, will provide the average individual with the daily RDA for protein, totaling about 45 grams of high quality protein. Combining this animal protein intake with plant foods high in protein, such as whole-grain products, beans and peas, and vegetables, will substantially increase your protein intake and more than meet recommended daily allowances.

4. Eat more complex carbohydrates, fiber, and natural sugars. In general, about 60 percent of your daily Calories should come from carbohydrates, about 50 percent from complex carbohydrates and the other 10 percent from simple, natural carbohydrates. Eat more legumes (beans and peas), and vegetables and fruits. Stress vegetables and fruits high in beta-carotene and vitamin C, such as carrots, peaches, and sweet potatoes. Deep yellow and orange fruits and vegetables, as well as dark green, leafy vegetables are usually good sources of these vitamins. Also, increase your intake of cruciferous vegetables, those from the cabbage family, such as broccoli, cauliflower, brussel sprouts, and all cabbages. These fruits and vegetables appear to protect you against lung, stomach, colon, and rectal cancer.

   Complex carbohydrates have a high fiber content. Fruits, beans, and oat products are rich in the water-soluble type of fiber. The high fiber content of these foods is believed to be important in the prevention of diseases such as cancer of the colon and coronary heart disease.

5. Use simple sugars in moderation. The recommended dietary goal is to reduce consumption of refined sugar from the current level of 24 percent of the daily Calories to 10 percent or less. Excessive consumption of refined sugar is associated with high blood triglyceride levels and sticky sugars are a major contributing factor to dental cavities.

6. The diet should be low in total fat, saturated fats, and cholesterol. The recommended daily intake of fat is less than 30 percent. In addition, the amount of saturated fat in the diet should be 10 percent or less, and cholesterol intake should be limited to 300 milligrams or less per day, or about 100 mg per 1,000 Calories.

   Saturated fats and cholesterol are associated with high blood levels of triglycerides, a risk factor associated with atherosclerosis and coronary heart disease.

7. Consume salt and sodium in moderation. Try to limit sodium intake to less than 2,400 milligrams daily, which is the equivalent of 6,000 milligrams (6 grams) of salt. This amount will provide sufficient sodium for normal physiological functioning. Increased salt intake has been associated with high blood pressure.

8. Avoid taking dietary supplements in excess of the daily RDA. In general, dietary supplements of most vitamins and minerals are not necessary for individuals consuming a balanced diet.

9. Eat natural foods and avoid foods with additives, artificial coloring, nitrates and sulfites.

Proper Body Weight Through Nutrition

Body Morphology

Ectomorph - The entire body is slender and sparsely built. The bone structure is small, subcutaneous fat is almost nonexistent and the muscles are small, flat and wirey. The joints of the body have loose ligaments and are often hyperextensible. Ranges of motion may be 15-30% greater than what is considered the normal ranges. The arms and legs are long and spindly. The neck is long, the Adam's apple prominent and the head is often carried forward creating the "military neck". The lateral spinal curves are often more dramatic with a lordotic lumbar curve coupled with a kyphotic thoracic curve. Scoliosis is more common in this body type. With exercise training they can develop a wirey strength that is surprising. As weight is the main determinant of oxygen utilization, their light frame can afford them good endurance.

Endomorph - The entire body is heavy and can be obese without proper diet and exercise. The bone structure is heavy and the bones are dense. Subcutaneous fat is plentiful. There is considerable muscle bulk and the muscles are short. The joints of the body are large and the ligaments are tight and very thick and strong. The joints may not reach full extension. Range of motion may be 10-20% less than the "normal" found in the intermediate, mesomorph type.
The increased body mass demands greater oxygen consumption. The endomorph does well in "spurt" activity, or explosive efforts but is poorly suited for endurance.
The endomorph is strong and can be very powerful, even when appearing to be excessively obese.

Mesomorph - The mesomorph, also known as the intermediate type, is the classic example of form and anatomy. Generally, they are of "average" height, 5'7" to 5'1O" and they have classic proportions, i.e., total arm span equal to body length, total trunk length is approximately equal to limb length and the Law of Thirds apply, i.e., the arm length is three times the length of the outstretched hand, the leg length is three times the length of the foot, and the height of the head is one third the length of the torso.
The mesomorph has good muscle development, body fat percentage is 13-22% depending on sex and age, and connective tissue s strong and durable.

Ectomorph Susceptibilities

1. Hyperextensive joints / Lax ligaments leading to misalignment or dislocation.
2. Extra lumbar vertebra creating a weak, easily destabilized low back / poor posture.
3. A higher incidence of developmental deformities such as tropism and scoliosis.
4. Low blood pressure / Congestive heart condition.
5. Scapular "winging" or Sprengles deformity.
6. Susceptibility to upper respiratory tract infections, and lung congestion. This includes colds, flu, acute bronchitis, allergies and sinus problems.
7. Depression / Anxiety / Neurotic behavior / Endocrine excesses.
8. Slower healing with muscle or ligamentous injury necessitating longer rehab periods.

Endomorph Susceptibilities

1. Myocardial infarction / Coronary vessel blockage / Myocardial degeneration / Arteriosclerosis.
2. Emphysema.
3. Osteoarthritis and DJD.
4. High blood pressure / Diabetes / Gout.
5. Liver, kidney, gall bladder dysfunction.
6. Chronic low back pain / Obesity.
7. Rapid healing for most structural injuries with good return of strength.

Dietary Recommendations According to Body Type

Body Type	Goals	Dietary Strategies
Ectomorph - tall, slender, high metabolism	Increase body weight, and lean body mass, decrease body fat.	Increase calorie intake by 350 - 400 Kcal per day / Eat larger portions / eat 5 to 7 times per day / Increase protein to 1.5 - 2 grams per kg body weight.
Mesomorph - naturally muscular, long torso, full chest	Increase body weight, and lean body mass, decrease body fat.	Consume 60% of calories from carbohydrates / 1 to 1.5 grams of protein per Kg of body weight / Keep fat intake around 30% of total calories.
Endomorph - stocky build, slower metabolism	Decrease body weight, increase lean body mass, decrease body fat.	Decrease calorie intake by 500 Kcal per day / Consume low fat high fiber foods / Eat smaller more frequent meals.

Obesity

Obesity is caused by multiple genetic and or environmental factors. Genetic causes may include hormonal imbalances or impaired metabolism causing an individual to store excessive body fat.

Environmental factors may include low levels of physical activity and the consumption of foods high in fat content. Recent studies suggest that over 40-50% of Americans are obese.

Body Composition

Water (is approximately 60% of the average adult's weight.) Water content in protein-type tissues, such as muscle is about 72%. Water makes up approximately 10% of fat - type tissue.); bone-tissue; protein - tissue and fat.

Body Fat - is the total amount of fat in the body.

Lean Body Mass - consists of muscles, bones and organs such as the heart, liver, and kidneys.

Approximate Percentages of Body Weight Attributable to Body Fat and Lean Body Mass

	Adult Male	Adult Female
Total Body Fat	15%	26%
Essential Fat	3%	15%
Storage Fat	12%	11%
Lean Body Mass	85%	74%
Muscle	43%	36%
Bone	15%	12%
Other Tissues	27%	26%

Body Fat Percentage Levels

Rating	Males(18-30)	Females (18-30)
Athletic	6-10%	10-15%
Good	11-14%	16-19%
Acceptable	15-18%	20-25%
Overweight	19-24%	26-29%
Obese	25% or over	30% or over

Techniques to Estimate Body Fat

Bioelectrical impedance analysis (BIA) - is a computer formula which predicts body fat based on your estimated body water content.

Girth Measurements - a measure of regional fat distribution is the Waist: Hip Ratio (WHR), which is the waist girth, measured at the narrowest section of the waist, divided by the gluteal or hip girth, measured at the largest circumference including the buttocks.

Excessive body fat in males is a WHR greater than 0.90 - 0.95; females - a WHR greater than 0.80 - 0.85.

Skinfold Techniques - skinfold measures are taken at various body sites such as the arms and waist which are inserted into a formula to estimate percentage of body fat.

Underwater Weighing

Weight Control Basics

To maintain your current body weight you must have energy balance.

ENERGY OUTPUT = ENERGY INPUT

Negative energy balance - an individual loses weight if energy output is greater than energy input
Positive energy balance - if energy input is greater than energy output, an individual gains weight.
Proper energy balance is the key to weight control.

Energy expenditure is due to:

Basal metabolic rate, BMR (60-75% of an individual's total daily energy expenditure is accounted for by the BMR), which is the measurement of energy expenditure in the body under resting, post-absorptive conditions.

Resting metabolic rate, RMR, is the BMR plus any energy expenditure due to digestion of food, and sedentary activities.

Exercise metabolic rate, EMR, is the energy expenditure during physical exercise. In sedentary individuals, EMR accounts for 10-15% of the daily energy expenditure. In physically active individuals, EMR may account for 30% or more of the daily energy expenditure. Exercise helps to release fat (free fatty acids) from adipose tissues. The fat then travels in the blood to muscles, where the free fatty acids are oxidized to provide energy.

Body Weight Regulators

The control of appetite is centered in the hypothalamus portion of the brain. The hypothalamus has a hunger center which stimulates eating behavior and a satiety center, which when stimulated, inhibits the hunger center.

Factors That Influence The Hypothalamus

- Senses, like taste and smell, can stimulate or depress appetites.
- An empty stomach stimulates the hunger center, whereas a full stomach stimulates the satiety center.
- Receptors in the hypothalamus monitor blood levels of various nutrients such as glucose, fats and proteins thereby influencing hunger and satiety.
- The hypothalamus detects changes in body temperature. An increase in body temperature inhibits the hunger center.
- Hormones, such as insulin, can influence feeding behavior.

The Nutritional Needs of the Athlete

Carbohydrates:

In the early stages of moderate exercise, carbohydrates provide 40 to 50 percent of the energy requirement. Carbohydrates yield more energy per unit of oxygen consumed than fats. Because oxygen often is the limiting factor in long duration events, it is beneficial for the athlete to use the energy source requiring the least amount of oxygen per kilocalorie produced. As work intensity increases, carbohydrate utilization increases.

Complex carbohydrates come from foods such as spaghetti, potatoes, lasagna, cereals and other grain products. Simple carbohydrates are found in fruits, milk, honey and sugar. During digestion, the body breaks down carbohydrates to glucose and stores it in the muscles as glycogen. During exercise, the glycogen is converted back to glucose and is used for energy. The ability to sustain prolonged vigorous exercise is directly related to initial levels of muscle glycogen. The body stores a limited amount of carbohydrate in the muscles and liver. If the event lasts for less than 90 minutes, the glycogen stored in the muscle is enough to supply the needed energy. For events that require heavy work for more than 90 minutes, a high-carbohydrate diet eaten for two to three days before the event allows glycogen storage spaces to be filled. Long distance runners, cyclists, cross-country skiers, canoe racers, swimmers and soccer players report benefits from a precompetition diet where 70 percent of the calories comes from carbohydrates.

According to the Olympic Training Center in Colorado Springs, endurance athletes on a high-carbohydrate diet can exercise longer than athletes eating a low-carbohydrate, high-fat diet. For continuous activities of three to four hours, make sure that glycogen stores in the muscles and liver are at a maximum. Consider taking carbohydrates during the event in the form of carbohydrate solutions. The current recommendation is a 6 to 8 percent glucose solution.

A diet where 70 percent of calories comes from carbohydrates for three days prior to the event is sometimes helpful for endurance athletes. (See Table 1 for a sample menu.) Water retention often is associated with carbohydrate loading. This may cause stiffness in the muscles and sluggishness early in the event.

Water

Water is an important nutrient for the athlete. Athletes should start any event hydrated and replace as much lost fluid as possible by drinking chilled liquids at frequent intervals during the event. Chilled fluids are absorbed faster and help lower body temperature.

Recommendations for hydration.	
Day before	**Drink fluids frequently**
Pre-event meal	2-3 cups water
2 hours before	2-2 1/2 cups water
1/2 hour before	2 cups water
Every 10-15 minutes during the event	1/2 cup cool (45-55 degrees) water
After event	2 cups fluid for each pound lost
Next day	Drink fluids frequently (it may take 36 hours to rehydrate completely).

Fats

Fat also provides body fuel. For moderate exercise, about half of the total energy expenditure is derived from free fatty acid metabolism. If the event lasts more than an hour, the body may use mostly fats for energy. Using fat as fuel depends on the event's duration and the athlete's condition. Trained athletes use fat for energy more quickly than untrained athletes.

Fat may contribute as much as 75 percent of the energy demand during prolonged aerobic work in the endurance-trained athlete.

Protein:

After carbohydrates and fats, protein provides energy for the body. Exercise may increase an athlete's need for protein, depending on the type and frequency of exercise. Extra protein is stored as fat. In the fully grown athlete, it is training that builds muscle, not protein per se. A protein intake of 10 to 12 percent of total calories is sufficient. Most authorities recommend that endurance athletes eat between 1.2-1.4 grams protein per kg of body weight per day; resistance and strength-trained athletes may need as much as 1.6-1.7 grams protein per kg of body weight. (A kilogram equals 2.2 pounds.)

To calculate your protein needs, divide your ideal weight by 2.2 pounds to obtain your weight in kilograms. Then multiply kilograms by the grams of protein recommended.

Vitamins and Minerals:

There is no evidence that taking more vitamins than is obtained by eating a variety of foods will improve performance. Excessive amounts of fat-soluble vitamins may have toxic effects.

Minerals play an important role in performance. Heavy exercise affects the body's supply of sodium, potassium, iron and calcium. To replenish sodium lost through sweating, eat normally following the competition. Avoid excessive amounts of sodium. Eating potassium-rich foods such as oranges, bananas and potatoes supplies necessary potassium.

The Pre-Game Meal:

A pre-game meal three to four hours before the event allows for optimal digestion and energy supply. Most authorities recommend small pre-game meals that provide 500 to 1,000 calories.

The meal should be high in starch and the starch should be in the form of complex carbohydrates (breads, cold cereal, pasta, fruits and vegetables).

Avoid a meal high in fats. Fat takes longer to digest. Fiber has a similar effect, as well.

Two pre-event meal plans.	
Pre-Event Meal Plan I (approximately 500 calories)	
Milk, skim	1 cup
Lean meat or equivalent	2 ounces
Fruit	1 serving (1/2 cup)
Bread or substitute	2 servings
Fat spread	1 teaspoon
Pre-Event Meal Plan II (approximately 900 calories)	
Milk, skim	2 cups
Cooked lean meat or equivalent	2 ounces

Fruit	1 serving (1/2 cup)
Pasta or baked potato	1 cup or 1 medium
Bread or substitute	2 servings
Vegetable	1 serving (1/2 cup)
Fat spread	1 teaspoon
Dessert: Angel food cake or plain cookies	1 piece 2 cookies

A Basic Dietary Plan for an Athlete

With the following plan, instead of the athlete counting calories they merely calculate the number of servings from each food group that they need daily depending on their goals.

Food Group	**Trim Down**	**Shape Up**	**Gain**
Meats/Protein	7	9	10
Grains	10	13	16
Fresh Fruits	3	3	4
Vegetables	4	4	5
Dairy	2	2	3
Fats	2	3	6
Calories	**1,800**	**2,200**	**3,000**

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Ergogenic Aids

Ergogenic (performance enhancing) aids can include nutritional aids such as protein / amino acid supplements, vitamins / mineral supplements and carbohydrate loading, and pharmacological aids such as anabolic steroids, caffeine, human growth hormone, testosterone, androstenedione, creatine and dehydroespiandrosterone.

Anabolic Steroids

Androgenic anabolic steroids are drugs that have a function similar to that of androgenic hormones (commonly referred to as male hormones, such as testosterone). These hormones are responsible for secondary sex characteristics development (androgenic component) and growth acceleration by way of bone development and increased muscle mass (anabolic component). The androgenic properties of synthetic steroids are altered to decrease its masculinizing effect while the anabolic properties are increased for the desired muscular growth.

Steroid use is found among athletes who participate in sports requiring size, strength, speed and power are prime candidates for anabolic steroid use. Track and field athletes (shot putters, discus and hammer throwers, sprinters, decathletes), weight lifters, cyclists, boxers, swimmers, football, baseball and basketball players are some examples.
Steroid use is found in high school sports, college sports, and world class athletic events.
Non athletes use steroids for aesthetic reasons.

Research indicates steroids cause an increase in enzyme involvement and protein metabolism that stimulates protein synthesis. This elevation in protein synthesis enhances muscular growth. Exercise (resistance training), adequate protein consumption and anabolic steroids can all increase protein synthesis.

The Drug Enforcement Agency (DEA) has made anabolic steroids a Class III drug, which means a user can receive up to a year in prison and a $1,000 fine. Sellers can receive 5 years in prison and a $250,000 fine, and a second offense can bring as much as 10 years and a $500,000 fine.

Steroid Side Effects

- The body's normal production and secretion of gonadotropin is suppressed and may cause atrophy of the interstitial tissue in the testes.
- Luteinizing Hormone (LH) and Follicle Stimulating Hormone (FSH) are suppressed, which decreases testosterone production by the testes.
- Prostate enlargement.
- HDL cholesterol levels are markedly depressed.
- Liver damage (toxicity)
- Stunted growth (children)
- Acne
- Increased blood pressure
- Elevated aggressiveness
- Bone enlargement
- Male pattern baldness
- Enlarged breasts
- Increased sex drive

Human Growth Hormone (HGH)

Human growth hormone (HGH) contributes to the body's overall size gains throughout the developing years. Physicians have used HGH to treat children with abnormal growth in order to provide them with a normal growth pattern.

Researchers have attempted to use HGH (as an alternative to steroids) to facilitate increased size and strength in selected adult athletes. Physical changes will occur, but the research is not conclusive as to how effective and safe these changes may be.

Caffeine

Caffeine, a mild stimulant, has been linked with a possible carbohydrate sparing effect for endurance athletes (marathon runners, swimmers). Caffeine is a diuretic (used to control body water.)

Testosterone

Testosterone, the four-carbon ring from which every anabolic steroid is derived, is the most coveted muscle building hormone in existence.

Androstenedione ("Andro")

This "natural" hormone is produced in the body and converted in just one step to testosterone. "Andro", while not classified as a steroid, functions like one to boost testosterone levels so you train harder and recover more quickly. It is naturally found in meats and plants. "Andro" pills are more concentrated and may produce unwanted consequences such as acne, mood swings, male pattern baldness, abnormal prostate growth, increased sex drive, enlarged breasts, liver problems, create heart problems, and stunted adolescent growth. The NFL, NCAA, and USOC ban it. The Association of Professional Team Doctors recommends that it be banned from all sports.

DHEA (Dehydroepiandrosterone)

DHEA is a powerful steroid hormone produced by the adrenal gland. The FDA says it should not be sold without a prescription. Side effects include decreased testicle size, enlarged liver, and increased aggressiveness.

Creatine

Creatine is an amino acid found primarily in meat and fish but also available in tablet and powder forms. Research indicates that creatine helps you work harder, train longer, and build muscle faster by raising the energy level within muscles.

There is an upper limit to the creatine levels that can be achieved, so taking larger dosages does not help more; once the muscle becomes saturated, excess creatine is simply excreted by the kidneys. Vegetarians and occasional meat eaters achieve the most pronounced effect from supplementation, while meat eaters accumulate a negligible amount of additional creatine.

Creatine increases the capacity to train**,** and the increase in training eventually increases strength, size, and performance. Athletes taking creatine are more susceptible to muscle cramps, spasms, and pulls. Creatine can cause a 10 to 15 pound increase in body weight due to water retention in the muscles. This extra weight can negatively impact performance, reducing first-step quickness, acceleration, and speed. The long term effects of creatine use are yet unknown.

Glycogen Supercompensation

When an endurance athlete progresses through his event (such as a marathon), their body's glycogen (carbohydrate) content decreases as their distance increases. Since the body cannot continue to function optimally without some amount of carbohydrate available, the exercise intensity would ultimately drop. An example of glycogen depletion and total physical fatigue would be a marathon runner "hitting the wall" near the 20 mile section of a 26.2 mile run. Because of this occurrence, the athlete may attempt to saturate their muscles and liver with glycogen before an event so that they will have sufficient levels of carbohydrates available towards the end of their race. This "overload" technique is known as glycogen supercompensation, or carbohydrate loading. This process involves a combination of high carbohydrate consumption ("loading") and decreased physical activity ("tapering") several days prior to the race.

Glycogen supercompensation would not benefit a weight trainer. The weight trainer would never train continuously enough to completely deplete their glycogen stores. Glycogen supercompensation is a technique normally reserved for endurance athletes because glycogen depletion normally occurs after two or more hours of continuous, intense exercise. The weight trainer, should ingest a moderate amount of food several hours before their workout. This will help them to maintain a normal blood glucose level throughout their training period and will allow them to exercise without a full stomach.

Research Sources

1. Albert, B. et al, Molecular Biology of the Cell, 2nd Edition, Garland Publishing, N.Y., 1989.
2. Berne, R. Matthew, L., Physiology (3rd Edition) , Mosby Year Book, St. Louis, 1993.
3. Bhoola., K., et al., Kinins-Key Mediators in Inflammatory Arthritis, British Journal of Rheumatology, 1992.
4. Block, G., Dietary Guidelines, American Journal of Nutrition, 1991.
5. Coleman, Eugene, 52 Week Baseball Training, Human Kinetics, Champaign, Illinois, 2000.
6. Connor, William E, Importance of N-3 fatty acids in health and disease, American Journal of Clinical Nutrition, Vol. 71, 2000.
7. Food and Nutrition Board, Recommended Daily Allowances (10th Edition), National Academy Press, Washington, DC, 1989.
8. Guyton, A., Basic Neuroscience (2nd Edition) Textbook of Medical Physiology (8th Edition), W.B. Saunders, Philadelphia, 1991.
9. International Health News, Omega-3; Staying Fit With Fat, Vol. 1., 2000.
10. Mosby Medical Encyclopedia, C.V. Mosby Co., N.Y., 1985.
11. Seaman, D., Handbook for Chiropractic and Pain Control (2.2 Edition), DRS Systems, Inc., Asheville, N.C., 1993.

12. Simpoulous, A., Omega-3 fatty acids in health and disease and in growth and development, American Journal of Clinical Nutrition, 1991.
13. Souba, W., Modern Nutrition in Health and Disease (8th Edition), W.B. Saunders, Philadelphia, 1944.
14. U.S. Department Health and Human Services, The Surgeon General's Report on Nutrition and Health, Government Printing Office, 1988.
15. Williams, Melvin, Lifetime Fitness and Wellness, Brown and Benchmark Publishers, 1993.
16. Zeman, F., Clinical Nutrition and Dietetics. (2nd Edition), Mac Millan Publishing, N.Y., 1993.
17. Williams, Melvin, Lifetime Fitness & Wellness, Brown and Benchmark Publishers, 1993, pg 98.
18. The Surgeon General's Report on Nutrition and Health, U.S. Dept Health & Human Services, U.S. Government Printing Office, Wash, D.C. 1988.
19. Williams, Melvin, Lifetime Fitness & Wellness, Brown and Benchmark Publishers, 1993, pg 135.
20. Colman, Eugene, 52 Week Baseball Training, Human Kinetics, Champaign, Illinois, page 10, 2000.
21. International Health News, Vol. 1, 2000, Omega-3: Staying Fit with Fat.
22. Simpoulous, A., Leaf, A., Salem, N., NIH Workshop on the Essentials of Recommended Dietary Intake for Omega-6 and Omega-3 Fatty Acids, 1999.
23. Mosby Medical Encyclopedia, C.V. Mosby Co, New York, NY, 1985, Pg 158.
24. Williams, Melvin, Lifetime Fitness & Wellness, Brown and Benchmark Publishers, 1993, pg 104.
25. Williams, Melvin, Lifetime Fitness & Wellness, Brown and Benchmark Publishers, 1993, pg 107.
26. Williams, Melvin, Lifetime Fitness & Wellness, Brown and Benchmark Publishers, 1993, pg 108.
27. Williams, Melvin, Lifetime Fitness & Wellness, Brown and Benchmark Publishers, 1993, pg 110.
28. Williams, Melvin, Lifetime Fitness & Wellness, Brown and Benchmark Publishers, 1993, pg 114.

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[1] http://iml.jou.ufl.edu/projects/Fall02/Greene/history.htm
[2] http://iml.jou.ufl.edu/projects/Fall02/Greene/history.htm
[3] http://www.health.gov/dietaryguidelines/
[4] http://www.answers.com/library/Wikipedia-cid-56389
[5] http://en.wikipedia.org/wiki/Peristalsis
[6] http://www.cic-caracas.org/departments/science/Topic5.php
[7] http://www.answers.com/topic/metabolic-pathway
[8] http://www.answers.com/library/Wikipedia-cid-56389
[9] http://www.teachersdomain.org/resource/tdc02.sci.life.cell.krebs/
[10] http://shortie894.tripod.com/id1.html
[11] http://www.google.com/imgres?imgurl=http://www.biochem.arizona.edu/
[12] Williams, Melvin, Lifetime Fitness & Wellness, Brown and Benchmark Publishers, 1993, pg 114.
[13] http://www.mypyramid.gov/
[14] http://www.health.gov/dietaryguidelines/dga2005/document/html/chapter5.htm
[15] Behavioral Risk Factor Surveillance System, Surveillance for Certain Health Behaviors Among Selected Local Areas-United States, Behavioral Risk Factor Surveillance System, 2002, Morbidity and Mortality Weekly Report (MMWR), 53, No SS-05. http://www.cdc.gov/brfss/.
[16] Youth Risk Behavior Surveillance System, Youth Risk Behavior Surveillance-United States, 2003 MMWR 53(SS-2):1-29, 2004. http://www.cdc.gov/healthyyouth/yrbs/.
[17] http://www.cdc.gov/nccdphp/dnpa/physical/terms/index.htm
[18] http://www.health.gov/dietaryguidelines/dga2005/document/html/chapter5.htm
[19] http://www.chap.com/diet4.htm