PROTEIN

After water, protein is the next most plentiful component of our body. The body manufactures proteins to make up hair, muscles, nails, tendons, ligaments, and other body structures. Proteins also function as enzymes, hormones, and as important components to other cells, such as our genes. The human body contains somewhere between 30,000 and 50,000 unique proteins. The building blocks for all proteins are molecules known as amino acids.

The body strives to make good use of its protein. During a single day, about a pound of an adult's body protein is broken down into amino acids and reassembled into new proteins. The protein is either broken down or manufactured to allow us to maintain the integrity of the proteins subjected to daily wear-and-tear. This protein turnover allows us to grow, heal, remodel, and internally defend ourselves on a continual basis. We can manufacture some amino acids. However, adequate dietary protein intake is essential in providing us with those amino acids that we cannot make, called essential amino acids.

The government mandated Recommended Dietary Allowance (RDA) for protein is based on body weight. Take a minute to calculate your protein requirement. The amount is usually considerably less than the amount most Americans typically take in. The RDA for grams of protein needed is calculated as follows:

.36 grams x (your weight in pounds)

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.8 grams by (your weight in kilograms)

Recommended Dietary Intake of Protein (g)

	Age	US RDI
Infants	Up to 6 months	13
	6 months-1 year	14
	1-3	16
Children	4-6	24
	7-10	28
Males	11-14	45
	15-18	59
	19-24	58
	25-50	63
	51+	63
Females	11-14	46
	15-18	44
	19-24	46
	25-50	50
	51+	50
Pregnant		60
Lactating	First 6 months	65
	Second 6 months	62

The average American easily reaches and often exceeds this protein requirement without even being on a high protein diet. Actual daily protein consumption ranges from 88-to-92 grams for men and 63-to-66 grams for women.

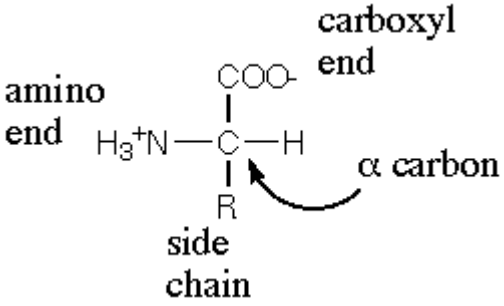
There are, however, many conditions in which extra protein is needed, including childhood/adolescence (growth), pregnancy, lactation, intense strength and endurance training, and when living with some, diseases such as AIDS and cancer. Elderly persons also may require additional amounts of protein. In these cases, multiply .8 grams by your weight in pounds. This will equal the grams of protein needed each day in a high protein diet.

The body does not store excess protein, so it must be excreted and can become a burden for the kidney and liver. And, contrary to popular belief, you can get fat eating a high protein diet. Excess protein intake increases the use of amino acids as a daily energy source as opposed to other sources of energy, such as carbohydrate or fat. As a result the breakdown and utilization of fat for energy is decreased, thereby maintaining or increasing body fat content.

AMINO ACIDS AND PROTEIN STRUCTURE

Proteins are composed of individual building blocks known as amino acids. Amino acids are compounds containing carbon, hydrogen, oxygen, nitrogen, and in some cases, sulphur. All amino acids have an acid group and an amino group attached to a carbon atom. The figure below shows the general structure of an amino acid. The R in the figure signifies a different molecule for every amino acid. In the simplest amino acid, *glycine,* R is a hydrogen atom, but in other amino acids the R is much more complex.

Basic Amino Acid Structure



The human body can manufacture most of the amino acids required for making body proteins. However, there are nine essential amino acids that the body cannot manufacture. The quality of a protein source is based on its level of these essential amino acids along with its digestibility and ability to be utilized by the body.

Essential and Non-Essential Amino Acids

Essential Amino Acids	Non-Essential Amino Acids
Arginine*	Alanine
Histidine*	Asparagine
Isoleucine	Aspartic acid
Leucine	Cysteine
Lysine	Glutamic acid
Methionine	Glutamine
Phenylalanine	Glycine

Threonine	Proline
Tryptophan	Serine
Valine	Tyrosine

*Essential during growth

The amino group of one amino acid can link with the acid group or carboxyl end of another amino acid to form a chain. The link is called a peptide bond. When two amino acids are joined together, a dipeptide is formed; when many amino acids join together, a polypeptide is formed. A typical protein may contain 500 or more amino acids, joined together by peptide bonds. Each protein has its own specific number and sequence of amino acids.

Name	Description
Dipeptide	Linkage of 2 amino acids
Tripeptide	Linkage of 3 amino acids
Peptides	Linkage of between 4 and 10 amino acids
Polypeptides	Linkage of greater than 10 amino acids
Proteins	Very long linkages of amino acids (> 100) and/or more than one linkage complexed together

Some smaller proteins will exist as a somewhat straight chain of amino acids, but most proteins will exist in a complex 3-dimensional pattern. Links of amino acids will contort themselves based upon the sequencing of the amino acids. Some amino acids are attracted to other amino acids in the chain while others are repulsed. This is due to either opposing or similar charges associated with the side chains of amino acids. Also, as the amino acid chain bends, twists, and warps about 3-dimensionally, certain amino acids will covalently bond, creating a disulfide bond, to other amino acids on another part of the chain. This helps stabilize the final 3-dimensional design.

Individual amino acids can also be used to make certain hormones and neurotransmitters such as epinephrine, serotonin, norepinephrine, insulin, and thyroid hormone. In addition, amino acids are used to make other important substances, such as choline, carnitine, and nucleic acids in our DNA.

PROTEIN QUALITY

A complete protein source is one that provides all of the nine essential amino acids in adequate amounts. Animal products such as, meat, fish, dairy, and poultry, are examples of complete proteins. Plant foods, especially grains and legumes, often lack one or more of the essential amino acids, but become complete protein sources when they are combined. For example, combining grains with legumes results in a complete protein as the two protein sources complement each other in their amino acid profiles. With a varied diet of grains, legumes, fruits, and vegetables, a person is almost assured complete proteins, as long as the calorie content of the diet is high enough. Nonetheless, when electing to eat less animal foods in the diet, it is important to design the diet to provide adequate amounts of protein.

In order to assess the quality of a protein, scientists measure the proportion of the amino acids that are absorbed, retained, and used in the body to determine the protein's *biological value* (BV). The food source that has the highest biological value protein is whey protein. Whey is a natural by-product of the cheese making process. Cow's milk has about 6.25% protein. Of that protein, 80% is casein (another type of protein), and the remaining

20% is whey. When cheese is made, it uses the casein molecules, leaving the whey behind. Whey protein is made via filtering off the other components of whey such as lactose, fats, and minerals.

One of the key reasons why the BV of whey protein is so high is that it has the highest concentrations of glutamine and branched-chain amino acids (BCAAs) found in nature. Glutamine and branched-chain amino acids are critical to cellular health, muscle growth, and protein synthesis. Glutamine specifically helps regenerate cells in the intestine.

Whey protein can be used to support recovery from surgery, prevent the "wasting syndrome" of AIDS and cancer, and offset some of the negative effects of radiation therapy and chemotherapy.

Biological Value of Selected Protein Sources

Whey (ion-exchange, micro-filtered)	100	Soybeans	72.8
Whole egg	93.7	Rice, polished	64.0
Milk	84.5	Wheat, whole	64.0
Fish	76.0	Corn	60.0
Beef	74.3	Beans, dry	58.0

ANIMAL PROTEIN VS. PLANT PROTEIN

In the United States, it is estimated that approximately 72% of protein in the diet is from animal products. Specifically, 49% from meat, fish, and poultry; 18% from dairy; and 4% from eggs. In contrast, plant foods account for only 28% of protein intake. Grain products provide 18%, fruits and vegetables provide about 8%, and legumes about 3%.

It is often difficult to separate out the effects of animal protein from the effects of animal fats because they are so highly correlated. That is, when animal protein intake is high, animal fat intake is typically also high. This makes it difficult for researchers to determine what the effects of a high protein diet are based on population studies as the source of protein cannot be identified. Despite this obstacle, there is much evidence that the reliance on animal proteins to meet protein requirements is linked to the development of several chronic degenerative diseases. For example, there is evidence that the body handles animal proteins differently from plant proteins. This is supported by population studies and animal studies comparing vegetarians to omnivores. Such evidence indicates that it is not simply a matter of protein quantity that is important, but that the source of the protein is equally important.

A high intake of animal protein is linked to heart disease, many cancers, high blood pressure, kidney disease, osteoporosis, and kidney stones. Heart disease and high blood pressure are associated with increased intake of animal fats as well as animal protein. Cancer can be caused by proteins that are altered in some cooking processes, such as grilling and blackening, and by the action by gut bacteria on undigested protein. The kidneys are responsible for eliminating the breakdown products of protein, too much of which can have a damaging effect. The last two diseases deal with calcium metabolism as a high-protein diet increases the excretion of calcium in the urine. Simply raising the intake of protein from 47 grams per day to 142 grams per day doubles the excretion of calcium in the urine. A diet this high in protein is common in the United States is a significant factor in the increased number of people suffering from osteoporosis and kidney stones in this country. A vegetarian diet is associated with a reduced risk for the above-mentioned diseases.

Protein Sources

Very Lean Meats

- Poultry: Chicken or turkey (white meat, no skin), Cornish hen (no skin)
- Fish: Fresh/frozen cod, flounder, haddock, halibut, trout; tuna fresh or water canned
- Shellfish: clams, crab, lobster, scallops, shrimp, imitation shellfish
- Game: Duck or pheasant (no skin), venison, buffalo, ostrich
- Fat-free cheese
- nonfat or low-fat cottage cheese
- Non-fat soy milk
- Processed sandwich meats with 1 gram or less fat per ounce
- Egg whites
- Egg substitutes, plain
- Prepared meats 1 gram or less fat per ounce*
- Dried beans

Lean Meat

- Beef: USDA Select or Choice grades of lean beef trimmed of fat such as round (top, eye, tip, bottom); tenderloin; roast (rib, chuck, rump, shoulder); steak (T-bone, porterhouse, cubed, shoulder, flank, sirloin), ground round,
- Pork: lean pork, such as fresh horn; conned, cured, or boiled horn; Canadian bacon (400 mg sodium); tenderloin, center loin chop
- Lamb: Roost, chop, leg
- Veal: lean chop, roast
- Poultry: Chicken, turkey (dark meat, no skin), chicken white meat with skin, domestic duck or goose (well drained of fat, no skin)
- Fish: Herring (uncreamed or smoked), Salmon (fresh or canned), catfish, Tuna (canned in oil drained), Sardines (canned)
- Seafood: Oysters
- Game: goose (no skin), rabbit
- Cheese w/ 3 grams or less fat per ounce, such as Parmesan
- 4.5%-fat cottage cheese
- Prepared meats with 3 grams or less fat per ounce

Here is a list of protein sources followed by a discussion comparing their relative merits.

Protein sources:	**Protein (in grams)**	**Fat (in grams)**
Almonds, 1 cup	24	70
Bagel	6	2
Barley, 1 cup (cooked)	16	2
Beans: pinto, etc., 1 cup (cooked)	15	1
Beef, lean, 5 X 5 X 3/4”	22	5
Beef, fat, 5 X 5 X 3/4”	22	16
Black-eyed peas, 1 cup (cooked)	13	1
Bran flakes cereal	4	1
Bread, white, 1 slice	2	1
Bread, whole wheat, 1 slice	3	1
Cheese, 1 oz.	7	9
Chicken breast, fried	26	5

Chicken pot pie, homemade	23	31
Clams, 3 oz.	65	11
Cottage cheese, 1 cup, 1% fat	31	4
Crabmeat, 1 cup	135	24
Egg, 1 lg.	6	6
Fish, white, 3 oz.	17	5
Ham, 3 oz.	18	19
Hamburger, lean, 5” patty	30	13
Hamburger, fat, 5” patty	30	22
Lentils, 1 cup (cooked)	16	trace
Liver, beef, 3 oz.	22	9
Milk, 1 cup 2%	8	8
Milk, 1 cup skim	8	trace
Oatmeal, 1 cup (cooked)	5	2
Peanuts, 1 cup, roasted in oil	37	72
Peanut butter, 1 Tbs.	4	8
Porkchop, 1 medium	19	25
Pumpkin seeds, 1 cup	35	65
Rice, white, 1 cup	4	trace
Salmon, 3 oz.	20	10
Shredded wheat cereal, 1 cup	2	1
Split peas, 1 cup (cooked)	16	1
Steak, with fat, 6 oz.	40	54
Steak, fat trimmed, 6 oz.	40	8
Sunflower seeds, 1 cup	35	69
Tofu, 4 oz.	9	6
Tofu burger, 1 patty	6	6
Tuna, in water, 3 oz.	24	3
Turkey, dark meat , 2-1/2 X 1-1/2 X 1/4”	26	7
Turkey, white meat, 4 X 2 X 1/4”	28	3
Veal cutlet, 3 oz.	23	9
Yogurt, 8 oz., low fat	10	3

** Please note that the fat content is also given. If you are interested in restricting the quantity of fat in your diet you will want to choose the leaner protein sources.