Extension Division
Virginia Polytechnic Institute
and State University

PROTEIN

Prepared by
Jo Anne Barton, Extension Specialist, Foods and Nutrition

The word protein is derived from the Greek and means "to come first." Protein is found in every cell in the body. It is second only to water in the amount found in the body. The major portion of the protein is located in muscle tissue; the remainder is found in blood, other soft tissues such as the heart, lungs, and brain, and in bones and teeth.

The nature and behavior of protein in cells of various tissues are different. The protein in muscle allows for contractibility. The protein in skin, hair, and nails is hard and insoluble, providing a protective covering for the body. The protein in the walls of the blood vessels contributes elasticity which is essential for maintaining normal blood pressure. The minerals, calcium and phosphorus, in bones and teeth are embedded in a framework of protein. Enzymes and hormones which regulate vital body processes are protein in nature. Gamma globulin, a protein found in the blood, is an antibody which helps the body fight infection.

Proteins are made up of amino acids. There are 20 amino acids all of which contain carbon, hydrogen, oxygen, and nitrogen. Two also contain sulfur. These 20 amino acids can be joined to make an infinite number of proteins. This may be easier to visualize if one thinks of the number of words which can be made from 26 letters.

The nitrogen content makes protein different from carbohydrates and fats. In fact, the nitrogen content is used to estimate the amount of protein in a food. Nitrogen makes up about 16% of protein so researchers determine the nitrogen content of a food and use that information to estimate the protein content.

Plants can use the simple, nitrogen-containing inorganic compounds in the soil to build protein. Some bacteria can even utilize nitrogen from the air but animals, including man, cannot use these simpler forms of nitrogen. Man is dependent on plants to incorporate nitrogen into the amino acids he needs. Much plant protein is consumed by animals which in turn are consumed by humans.

Eight of the amino acids are classed as essential or indispensable and must be provided in the diet. The essential amino acids are isoleucine, leucine, lysine, methionine, phenylalanine, threonine, trytophan, and valine. Occasionally, one sees reference to one or more of these amino acids. For example, infants who have phenylketonuria (PKU) lack the ability to use phenylalanine.

The non-essential amino acids (all others except the eight essentials) are important in building body proteins. However, they can be made by the body as needed and do not have to be supplied preformed from foods.

Food proteins, whether of plant or animal origin, have to be broken down into the individual amino acids. The body rejoins the amino acids to make the different proteins which are needed.

FOOD PROTEIN - BODY PROTEIN

Our method of getting amino acids by taking apart complex protein foods is a little like demolishing an old house for the bricks for a new house. There are many other materials in the old house besides the bricks we are seeking. Also, there are many other substances in the egg, chicken leg, or slice of roast beef besides protein.

An egg has protein of the very highest quality, but a 50 gram egg has only 6 grams of protein. There's more water (37g) and as much fat (6g) as there is protein. The protein content of most meat, fish, and poultry is no more than 20 to 30% after cooking. The leaner meat cuts such as beef round, veal, lamb, and non-oily fish have slightly more protein than similar weights of fatter meats. Most nuts are 15-17% protein by weight, breads 8-10%, milk 3 1/2%, and legumes 5-11%.

Part of the breakdown of protein in the body is done by the large-scale processes of digestion such as the mechanical churning and strong acid of the stomach. But, most of the work is done by enzymes which themselves are a type of protein.

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The amino acids are absorbed almost entirely from the small intestine usually within 12 hours after the protein food is eaten. The amino acids are carried to the cells by the blood stream. Each cell removes the amino acids needed to build its special kind of protein. If an essential amino acid is missing, the protein cannot be made by the body.

Thus, a complete dietary protein has all of the essential amino acids; an incomplete protein has a limited quantity of one or more of the essential amino acids. The amino acid which is in short supply is the "limiting" amino acid. Lysine is the limiting amino acid for wheat and many other grains. Methionine is the limiting amino acid for soybeans and other mature beans and peas.

In general, animal proteins have an adequate supply of the essential amino acids while vegetable and plant proteins tend to be low in one or more essential amino acids.

Combinations of foods can improve the mix of amino acids and the quality of the protein if foods are selected with complementary amino acid patterns. It won't help to combine wheat and oats because both are lacking in lysine, but a combination of wheat and beans does result in a better quality protein as does milk with cereals.

Rao and Swaminathan summarized a number of research studies showing these complementary relationships: peanut proteins supplement wheat, oat, corn, rice, and coconut proteins to a significant extent: soybean proteins are rich in lysine and valine and so supplement those of wheat, corn, and rye; a mixture of soy and sesame proteins has a high nutritive value comparable to milk proteins; and the proteins of legumes and leafy vegetables remarkably supplement those of cereals.

PROTEIN NEEDS

How much protein one needs depends on rate of growth and body size. The faster the body is growing, the more protein is needed for building. The larger the mass of living tissue, the more protein it must have for maintenance and repair.

A child grows faster during the first year of life than at any other time. The second fastest growing period is during adolescence. The total need for protein increases as children get larger because there is more and more tissue to keep supplied and replenished with protein. Protein cannot be used for growth until after maintenance needs have been met. When there is not enough protein for both purposes, growth suffers first.

The Recommended Dietary Allowance for protein for adults is 0.8 grams of protein for each kilogram (2.2 lbs.) of body weight. Thus, a man weighing 70 kg (154 lbs.) would need 56 grams of protein daily; a woman weighing 58 kg (128 lbs.) would need 46 grams of protein.

Table 1

Recommended Dietary Allowances*

	Age (years)	Protein (g)
Infants	0.0-0.5	kg x 2.2
	0.5-1.0	kg x 2.0
Children	1-3	23
	4-6	30
	7-10	36
Males	11-14	44
	15-18	54
	19-22	54
	23-50	56
	51+	56
Females	11-14	44
	15-18	48
	19-22	46
	23-50	46
	51+	46
Pregnant		+30
Lactating		+20

*Established by the Food and Nutrition Board of the National Academy of Sciences — National Research Council, 1974.

STRUCTURE OF PROTEIN

Each gram of protein yields four calories when burned or oxidized by the body. The extent to which protein is used for energy depends on the total amount of food consumed. Protein is considered primarily a building and regulating substance, but if energy needs are not met by other foods, protein will be used to furnish energy.

Some persons seem to have the notion that the more protein in the diet, the better the diet, but there is little evidence to support this view. When the cells have the amino acids they need, additional amino acids will not be used to build protein. Also, the amino acids cannot be stored to be used at some future date. Surplus amino acids will be broken down with one part being burned as fuel, if needed, or stored as body fat. The nitrogen bearing part becomes urea which is removed from the body by the kidneys.

Protein foods are an expensive way of providing energy. One other factor to keep in mind is that protein foods are usually combined with fat and/or carbohydrate. When one decides to increase protein intake, calorie intake may go up as well. A second egg for breakfast does add 6 grams of protein but also adds 80 calories. Only 24 of those calories are due to the protein—the remainder are furnished by fat in the egg.

SOURCES OF PROTEIN

The meat and meat substitutes group of the Daily Food Guide supplies much of the protein needed daily, but milk and foods made from milk also supply good amounts of protein. A single serving of a bread or cereal product does not contribute a large amount of protein, but because of the quantity consumed by some individuals, the total contribution may be significant.

Table 2

Food*	Protein Content
	g
Turkey, 3 ounces	22
Beef, 3 ounces	22
Chicken, 3 ounces	22
Veal, 3 ounces	22
Lamb, 3 ounces	22
Pork, 3 ounces	22
Liver, 3 ounces	22
Fish, 3 ounces	20
Cottage cheese, 1/2 cup	15
Frankfurters, 2 medium	14
Dried beans and peas, 3/4 cup	11
Milk, 1 cup	9
Cheese, cheddar, 1 ounce	7
Luncheon meat, 2 ounces	7
Egg, 1 large	6
Peanut butter, 1 Tbsp.	4
Cereal, 1 cup	2
Bread, 1 slice	2

*Food as served

DIETARY ADEQUACY

Getting enough protein is not usually a major problem in this country. The average diet is more likely to be adequate in protein than in any other essential nutrient. In fact, many Americans could reduce protein intake without compromising the quality of the diet. However, certain groups of people are more likely to have inadequate intakes of protein than the general population. Vulnerable groups include teenagers because of high needs coupled with poor food habits; pregnant and lactating women because of increased demands for protein; weight watchers because of lowered intakes of food; members of families with limited incomes because of low intakes of animal proteins; and senior citizens and alcoholics because of altered dietary habits.

Another vulnerable group is composed of persons who have adopted dietary practices which limit or eliminate meat and other foods of animal origin. It is possible to get all of the amino acids needed from vegetable proteins if one chooses a wide variety of foods with a minimum of refined products. There are some difficulties, however. One is the fact that many plant foods are low in calories so the sheer bulk of food needed to meet caloric needs can become a problem. A second problem is the lack of vitamin B_{12} in plant foods. A third problem, if foods from the milk group are omitted, is a lack of calcium.

NUTRITION LABELING

Many food products now bear a nutrition information panel. Such label information is required on products to which one or more nutrients is added and/or for which nutrition claims are made. All food manufacturers and processors may choose to include a nutrition information panel. A standard format has been established for presentation of information about eight nutrients.

Standards for nutrition labeling have been established for four broad age categories: (1) infants, (2) children 1 to 4 years of age, (3) pregnant and lactating women, and (4) the rest of the population. The latter standard is the one used most frequently. Standards for labeling purposes are identified as the U.S. RDA and were based on the 1968 edition of the Recommended Dietary Allowances.

The nutrition information panel must indicate serving size, the number of grams of protein per serving, and the percentage of the U.S. RDA for protein per serving. Several sex-age groups were combined in establishing the U.S. RDA so they cannot be expected to fit all persons. For example, the U.S. RDA for protein is 65 grams for all persons over 4 years of age. Recommended Dietary Allowances (1974 revision) for various sex-age groups are shown in Table 1. You will see that the recommended intakes of protein for persons in the 4 and over age groups range from 30 to 56 grams. For some family members, an intake of 50% of the U.S. RDA for protein (32g) would be adequate to meet needs.

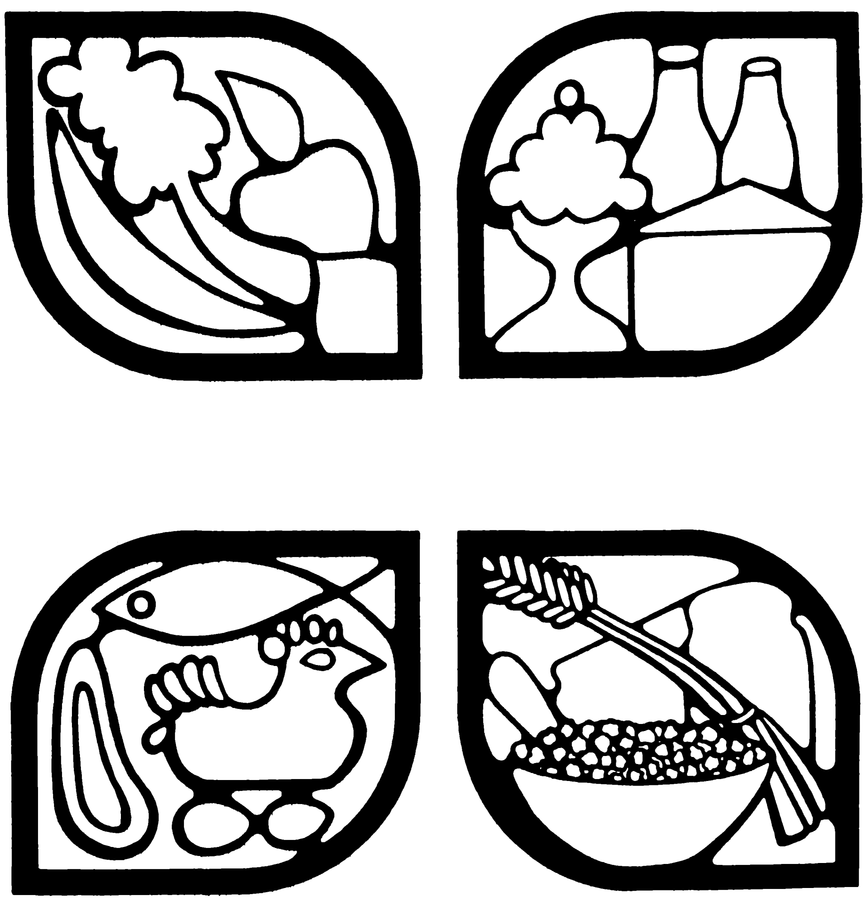
ADDITIONAL INFORMATION

If you are interested in additional information, consult one or more of these references.

(1) *Recommended Dietary Allowances,* Eighth Edition 1974. National Academy of Sciences, Washington, D.C.

(2) "The Vegetarian Diet" by U.D. Register and L. M. Sonnenberg in the Journal of the American Dietetic Association, March 1973.

(3) "Plant Proteins in the Amelioration of Protein Deficiency States" by M. N. Rao and M. Swaminathan in World Review of Nutrition and Dietetics, 1969.



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