Diet for a Small Planet
Twentieth Anniversary Edition

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Part III

Diet for a Small Planet Revisited
1. America's Experimental Diet

To eat the typical American diet is to participate in the biggest experiment in human nutrition ever conducted. And the guinea pigs aren't faring so well! With a higher percent of our GNP spent on medical care than in any other industrial country and after remarkable advances in the understanding and cure of disease, the life expectancy of a forty-year-old American male in 1980 was only about six years longer than that of his counterpart of 1900.

Why haven't our wealth and scientific advances done more for our health? Medical authorities now believe that a big part of the answer lies in the new American diet—an untested diet of high fat, high sugar, low fiber, which is now linked to six of the ten leading causes of death. (See Figure 4.)

The first two editions of this book are full of nonmeat recipes, just as this one is. But in my discussion of nutrition I stuck to the protein debate because I wanted to demonstrate that we didn't need a lot of meat (or any, for that matter) to get the protein our bodies need. Now I think I missed the boat, for the Diet for a Small Planet message can't be limited to meat. At root its theme is, how can we choose a diet that the earth's resources can sustain and that
Ten leading causes of death in the United States in 1979 with diet risk factors*

*Diets, of course, is not the only cause of these diseases.
can best sustain our bodies? To answer that, I had to investigate more than meat.

As I looked at the radical change in the American diet, I was most struck by our soaring meat consumption. In my lifetime beef consumption has doubled and poultry consumption has tripled. What I didn’t adequately appreciate was how much our entire diet had been transformed. In the 1977 Dietary Goals for the United States, health authorities summing up information gathered by the Senate Select Committee on Health and Nutrition concluded that Americans are eating significantly more fat, more sugar, and more salt, but less fiber and too many calories. No fewer than 16 expert health committees, national and international, now agree that each of these changes is linked to heightened risk of disease.¹ Many other people are concerned that the food additives and pesticide residues we are ingesting may also pose health hazards.

Most striking is that each of these health-threatening dietary changes is actually a byproduct of two underlying ones: more animal food, and more processed food. “Processed” simply means that between the ground and our mouths someone takes out certain things and puts in other things—and not always things that are good for us. The problem is not that Americans are adding more sugar and salt to their recipes or cooking with more fat; the problem is that these are being added for us. All we have to do is take the fatty, grain-fed steak from the meat counter, the potato chips from the shelf, or the Big Mac from its styrofoam package.

Eat at Your Own Risk

You’ll notice that when scientists speak of diet and disease they are careful to say that such-and-such a way of eating affects the “risk” of getting a particular disease. That’s because it is almost impossible to prove that diet causes a particular disease. For instance, you can’t prove that your father’s heart attack was caused by high blood pressure that was caused by his high salt diet.
Scientists must largely rely on "guilt by association." By comparing populations, they can observe which diets are associated with which types of disease. But comparing different societies with different diets is less than convincing, since there is always the possibility that genetic differences among populations and other environmental factors play a decisive role. So the most telling observations are those of a single population group which changes its diet. Here is a sampling of such evidence:

- The traditional Japanese diet contains little animal fat and almost no dairy products. Japanese who migrate to the United States and shift to a typical American diet have a dramatically increased incidence of breast and colon cancer.2

- The citizens of Denmark were forced to reduce their intake of animal foods by 30 percent during World War I, when their country was blockaded. Their death rate simultaneously fell 30 percent, to its lowest level in 20 years.3 Denmark's experience was not unique: in a number of European countries, where World War II forced people to eat less fat and cholesterol and fewer calories, rates of heart disease fell.

- In some third world countries a small class of urbanites have adopted the new American diet over the last 20 years. Coronary heart disease now occurs more and more frequently in some of those countries, such as Sri Lanka, South Korea, Malaysia, and the Philippines, the World Health Organization reports.4

Other important evidence comes from different diet and disease patterns in populations that are similar in most other ways. For example, a study of 24,000 Seventh Day Adventists living in California showed that the nonvegetarian Adventists had a three times greater risk of heart disease than those eating a plant food diet.5

In her fascinating, thoroughly researched book Jack Sprat's Legacy (Richard Marek, 1981), Patricia Hausman convinced me that health authorities around the world virtually all agree: the typical American diet is a high-risk diet. The "debate" over the risks associated with the new American diet is perpetuated by the media and vested interests in the meat, dairy, and egg industries, who have
spent millions of dollars trying to publicly deny these risks, despite overwhelming evidence to the contrary.

Eight Radical Changes in the U.S. Diet

The food industry was quick to attack the Senate Select Committee on Nutrition and Human Needs for daring in 1977 to suggest a change in the American diet. How ironic. Never has a people's diet changed so much so fast as ours has over the last 80 years. And that change, as we shall see, has been in large part caused by the food industry itself.

I have looked at each of these changes and asked, what are the risks associated with this change? And why the change? (By the way, the best detailed source on the "Changing American Diet" is an excellent book by that name (1978) written by Letitia Brewster and Michael Jacobson of the Center for Science in the Public Interest in Washington, D.C.)

I will discuss each change separately, but as nutritionist Dr. Joan Gussow wisely observes, our bodies don't experience these changes separately. "One of the handicaps of most 'scientific' investigations of the impact of dietary change is that each is studied separately, whereas the greater threat may be their cumulative impact," says Dr. Gussow. So we have to look at the whole cluster.

Dangerous Change No. 1: Protein from Animals Instead of Plants

Contrary to what I thought, the dramatic change is not in our protein consumption. It has actually varied little over the last 65 years, fluctuating between 88 grams and 104 grams per person per day (roughly twice what our bodies can use). The change is in how our protein is packaged. Sixty-five years ago we got almost 40 percent of our protein from grain, bread, and other cereal products. Now
3.

Protein Myths: A New Look

HAVING READ OF the vast resources we squander to produce meat, you might easily conclude that meat must be indispensable to human well-being. But this just isn’t the case. When I first wrote *Diet for a Small Planet* I was fighting two nutritional myths at once. First was the myth that we need scads of protein, the more the better. The second was that meat contains the *best* protein. Combined, these two myths have led millions of people to believe that only by eating lots of meat could they get enough protein.

Protein Mythology

*Myth No. 1: Meat contains more protein than any other food.*

*Fact:* Containing 20 to 25 percent protein by weight, meat ranks about in the middle of the protein quantity scale, along with some nuts, cheese, beans, and fish. (Check the “quantity” side of Figure 14, “The Food/Protein Continuum.”)
Myth No. 2: Eating lots of meat is the only way to get enough protein.
Fact: Americans often eat 50 to 100 percent more protein than their bodies can use. Thus, most Americans could completely eliminate meat, fish, and poultry from their diets and still get the recommended daily allowance of protein from all the other protein-rich foods in the typical American diet.

Myth No. 3: Meat is the sole source for certain essential vitamins and minerals.
Fact: Even in the current meat-centered American diet, nonmeat sources provide more than half of our intake of each of the 11 most critical vitamins and minerals, except vitamin B12. And meat is not the sole source of B12; it is also found in dairy products and eggs, and even more abundantly in tempeh, a fermented soy food. Some nutrients, such as iron, tend to be less absorbable by the body when eaten in plant instead of animal foods. Nevertheless, varied plant-centered diets using whole foods, especially if they include dairy products, do not risk deficiencies.

Myth No. 4: Meat has the highest-quality protein of any food.
Fact: The word "quality" is an unscientific term. What is really meant is usability: how much of the protein eaten the body can actually use. The usability of egg and milk protein is greater than that of meat, and the usability of soy protein is about equal to that of meat. (Check the "Usability" side of Figure 14.)

Myth No. 5: Because plant protein is missing certain essential amino acids, it can never equal the quality of meat protein.
Facts: All plant foods commonly eaten as sources of protein contain all eight essential amino acids. Plant proteins do have deficiencies in their amino acid patterns that make them generally less usable by the body than animal protein. (See the "Usability" side of Figure 14.) However, the deficiencies in some foods can be matched with amino acid strengths in other foods to produce protein usability equiva-
lent or superior to meat protein. This effect is called "protein complementarity."

**Myth No. 6: Plant-centered diets are dull.**

*Fact:* Just compare! There are basically five different kinds of meat and poultry, but 40 to 50 kinds of commonly eaten vegetables, 24 kinds of peas, beans, and lentils, 20 fruits, 12 nuts, and 9 grains. Variety of flavor, of texture, and of color obviously lies in the plant world... though your average American restaurant would give you no clue to this fact.

**Myth No. 7: Plant foods contain a lot of carbohydrates and therefore are more fattening than meat.**

*Fact:* Plant foods do contain carbohydrates but they generally don't have the fat that meat does. So ounce for ounce, most plant food has either the same calories (bread is an example) or considerably fewer calories than most meats. Many fruits have one-third the calories; cooked beans have one-half; and green vegetables have one-eighth the calories that meat contains. Complex carbohydrates in whole plant foods, grain, vegetables, and fruits can actually aid weight control. Their fiber helps us feel full with fewer calories than do refined or fatty foods.

**Myth No. 8: Our meat-centered cuisine provides us with a more nutritious diet overall than that eaten in underdeveloped countries.**

*Fact:* For the most part the problem of malnutrition in the third world is not the poor quality of the diet but the inadequate quantity. Traditional diets in most third world countries are probably more nutritious and less hazardous than the meat-centered, highly processed diet most Americans eat. The hungry are simply too poor to buy enough of their traditional diet. The dramatic contrast between our diet and that of the "average" Indian, for example, is not in our higher protein consumption but in the amount of sugar, fat, and refined flour we eat. While we consume only 50 percent more protein, we consume eight times the fat and four times the sugar. Our diet would actually be improved if we ate more plant food.
In earlier editions of *Diet for a Small Planet* I concentrated on the “meat protein mystique,” explaining why the body needs protein, how protein is ranked according to its usability by the body, and how you can combine plant proteins to create a protein mix that is just as usable by the body as is meat protein.

But it was the possibility of combining two or more less-usable proteins to create one of a better “quality” that most intrigued me. This neat trick is called “protein complementarity” and is explained fully in the next chapter. It doubly intrigued me when I realized that such food combinations evolved as the mainstay of traditional diets throughout the world.

Virtually all traditional societies based their diets on protein complementarity; they used grain and legume combinations as their main source of protein and energy. In Latin America it was corn tortillas with beans, or rice with beans. In the Middle East it was bulgur wheat with chickpeas or pita bread felafel with hummus sauce (whole wheat, chickpeas, and sesame seeds). In India it was rice or chapaties with dal (lentils, often served with yogurt). In Asia it was soy foods with rice (in southern China, northern Japan, and Indonesia), or soy foods with wheat or millet (in northern China), or soy foods with barley (in parts of Korea and southern China). In each case, the balance was typically 70 to 80 percent whole grains and 20 to 30 percent legumes, the very balance that nutritionists have found maximizes protein usability.

“Anglo students in Tucson had always put down the Chicanos for their ‘starchy’ diet,” *Arizona Daily Star* reporter Jane Kay told me. “But after your book came out, the Chicanos felt vindicated because it showed that the food the Mexican people in Tucson eat—lettuce, cheese, tortillas, and beans—is better than the all-American hamburger and fries.”

When I first wrote *Diet for a Small Planet* in 1971, the idea that people could live well without meat seemed much more controversial than it does today. I felt I had to prove to nutritionists and doctors that because we could combine proteins to create foods equal in protein usability to meat,
people could thrive on a nonmeat or low-meat diet. Today, few dispute that people can thrive on this kind of diet. In fact, more and more health professionals are actually advocating less meat precisely for health reasons, reasons I discussed in "America's Experimental Diet."

In 1971 I stressed protein complementarity because I assumed that the only way to get enough protein (without consuming too many calories) was to create a protein as usable by the body as animal protein. In combatting the myth that meat is the only way to get high-quality protein, I reinforced another myth. I gave the impression that in order to get enough protein without meat, considerable care was needed in choosing foods. Actually, it is much easier than I thought.

With three important exceptions, there is little danger of protein deficiency in a plant food diet. The exceptions are diets very heavily dependent on fruit or on some tubers, such as sweet potatoes or cassava, or on junk food (refined flours, sugars, and fat). Fortunately, relatively few people in the world try to survive on diets in which these foods are virtually the sole source of calories. In all other diets, if people are getting enough calories, they are virtually certain of getting enough protein. (Babies, young children, and pregnant women need some special consideration, which I'll discuss later.) This is true because the vast majority of unprocessed foods can supply us with enough protein to meet our daily protein allowance without filling us with too many calories. In Appendix D I present a simple rule of thumb for judging any food as a protein source. There you'll see that most plant foods excel—meaning that you could eat just one food and get enough protein.

The simplest way to prove the overall point is to propose a diet which most people would consider protein-deprived and ask, does its protein content add up to the allowance recommended by the National Academy of Sciences? In Figure 10 I have put together such a day's menu—with no meat, no dairy foods, and no protein supplements. Even without accounting for improved protein usability due to combining complementary proteins, this diet has adequate protein without exceeding calorie limits.
Figure 10. Hypothetical All-Plant-Food Diet (Just to Prove a Point)

<table>
<thead>
<tr>
<th>Breakfast</th>
<th>Calories</th>
<th>Total Protein (Grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 c. orange juice</td>
<td>111</td>
<td>1.7</td>
</tr>
<tr>
<td>1 c. cooked oatmeal</td>
<td>148</td>
<td>5.4</td>
</tr>
<tr>
<td>½ oz. sunflower seeds</td>
<td>80</td>
<td>3.5</td>
</tr>
<tr>
<td>1 tbsp. brown sugar</td>
<td>52</td>
<td>0</td>
</tr>
<tr>
<td>3 tbsp. raisins, dried seedless</td>
<td>87</td>
<td>0.9</td>
</tr>
</tbody>
</table>

| Lunch                              |          |                       |
| 2 tbsp. peanut butter              | 172      | 7.8                   |
| 2 slices whole wheat bread         | 112      | 4.8                   |
| 1 tbsp. honey                      | 64       | 0.1                   |
| 1 apple, medium, raw               | 87       | 0.3                   |
| 2 carrots, small, raw              | 42       | 1.1                   |

| Dinner                             |          |                       |
| 1 c. cooked beans                  | 236      | 15.6                  |
| 1 c. cooked brown rice             | 178      | 3.8                   |
| 3 stalks broccoli (approx. 1 1/3 c.) | 52     | 6.2                   |
| 4 mushrooms, large, raw            | 28       | 2.7                   |
| 2 tbsp. oil                        | 248      | 0                     |
| 1 c. apple juice, fresh canned    | 109      | 0.3                   |
| ½ banana, medium, raw              | 64       | 0.8                   |

| Snack                              |          |                       |
| 1½ c. popcorn, cooked with oil     | 123      | 2.7                   |

Total

<table>
<thead>
<tr>
<th>Calories</th>
<th>Total Protein (Grams)</th>
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<tbody>
<tr>
<td>1,993</td>
<td>57.7</td>
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National Academy of Sciences (NAS) recommended allowance for 128-lb. woman eating typical American diet

2,000     44

NAS recommended allowance adjusted for less usable protein in plant food diet, assuming no improvement in protein usability due to combining protein. (See page 172.)

2,000     55
Clearly this diet contains much more protein, 57.7 grams, than the National Academy of Science's recommendation of 44 grams of protein for an average American woman eating a typical American diet. But this allowance assumes that two-thirds of that protein is highly usable animal protein. Since my hypothetical daily menu contains no animal protein, and since I am trying to show that protein complementarity is not essential, let's adjust the National Academy's recommendation upward to what it would be for a plant food diet, assuming no protein complementarity. The allowance rises to about 55 grams. Yet my hypothetical diet still exceeds the allowance.

In the example, I used the weight and protein allowance of a typical American woman. But the same pattern would hold true for any weight person, since the protein allowance and calorie needs rise proportionately as body weight increases. For men, getting enough protein without exceeding calories limits is even a slight bit easier. (Men are allowed 2 more calories for every gram of protein than are women.)

Note that my hypothetical diet, while not intentionally protein-packed, is a healthy one. It contains few protein-empty foods, only sugar, honey, oil, an apple, and apple juice. They comprise only about 25 percent of the calories. The more of these protein-empty foods one eats, the more the rest of the diet should be filled with foods with considerable protein.

But a number of the world's authorities on protein believe that the current recommended daily protein allowance may be too low. At the Massachusetts Institute of Technology, three-month-long experiments, with subjects consuming the recommended amount of protein in the form of egg, for most subjects resulted in the loss of lean body mass and a decrease in the proteins and oxygen-carrying cells of the blood.

If the recommended allowance were pushed up by one-third, as some scientists believe it should be, would it then be difficult to eat enough protein without meat?

The average American woman's recommended allowance would then be 59 grams of protein. At this higher level, combining protein foods to improve the usability of
the protein would become more important. But in this hypothetical day's diet there are already complementary protein combinations (peanut butter plus bread, beans plus rice) which would bring the usability of the protein up closer to that assumed in the recommended allowance. To be totally safe, however, one might want to replace one of the protein-empty foods with an additional protein food if maintaining an all plant food diet. (For example, replacing the sugar and honey with grain or vegetable.)

Very few Americans, however, eat only plant foods. Even most vegetarians eat some dairy products. So in Figure 11 let's look at basically the same day's diet but this time put in two modest portions of dairy foods, one cup of skim milk and a one-inch cube of cheese. These changes bring the total protein up to 71 grams—well above even the highest standard recommended by some nutritionists.

**Protein Individuality**

But scientists studying the differences in individual needs for nutrients warn us that even the most prudently arrived at recommendations, claiming to cover 97.5 percent of the population, should not be followed blindly.

R. J. Williams at the University of Texas is one of the best-known of these scientists. He points out that if beef were the only source of protein, one person's minimum protein needs could be met by two ounces of meat; yet another individual might require eight ounces. These two extremes represent a fourfold difference. The recommended allowance of the National Academy of Sciences nonetheless assumes that a twofold variation between the highest and the lowest needs will cover 95 percent of the population.) Donald R. Davis, also at the University of Texas, recently reviewed the literature on individual needs for amino acids, protein's building blocks. Within small groups of subjects, differences ranged up to ninefold, states Davis.

In addition, the recommended allowances of protein are calculated for healthy people. Ill health and age, as well as genetic differences, could result in greatly differing needs.
Figure 11. Hypothetical Mixed Plant and Dairy Diet (Just to Prove a Point)

<table>
<thead>
<tr>
<th></th>
<th>Calories</th>
<th>Protein (Grams)</th>
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<tbody>
<tr>
<td><strong>Breakfast</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 c. orange juice</td>
<td>111</td>
<td>1.7</td>
</tr>
<tr>
<td>1 c. cooked oatmeal</td>
<td>148</td>
<td>5.4</td>
</tr>
<tr>
<td>½ oz. sunflower seeds</td>
<td>80</td>
<td>3.5</td>
</tr>
<tr>
<td>1 tbsp. brown sugar</td>
<td>52</td>
<td>0</td>
</tr>
<tr>
<td>1 c. low-fat milk</td>
<td>88</td>
<td>8.8</td>
</tr>
<tr>
<td><strong>Lunch</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 tbsp. peanut butter</td>
<td>172</td>
<td>7.8</td>
</tr>
<tr>
<td>2 slices whole wheat bread</td>
<td>112</td>
<td>4.8</td>
</tr>
<tr>
<td>1 tbsp. honey</td>
<td>64</td>
<td>0.1</td>
</tr>
<tr>
<td>½ apple, medium, raw</td>
<td>43</td>
<td>0.2</td>
</tr>
<tr>
<td>1 carrot, small, raw</td>
<td>21</td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Dinner</strong></td>
<td></td>
<td></td>
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<tr>
<td>1 oz. cheddar cheese (1 inch square)</td>
<td>112</td>
<td>7.0</td>
</tr>
<tr>
<td>1 c. cooked beans</td>
<td>236</td>
<td>15.6</td>
</tr>
<tr>
<td>1 c. cooked brown rice</td>
<td>178</td>
<td>3.8</td>
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<tr>
<td>3 stalks broccoli (approx. 1 1/3 c.)</td>
<td>52</td>
<td>6.2</td>
</tr>
<tr>
<td>4 mushrooms, large, raw</td>
<td>28</td>
<td>2.7</td>
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<tr>
<td>2 tbsp. oil</td>
<td>248</td>
<td>0</td>
</tr>
<tr>
<td>1 c. apple juice, fresh canned</td>
<td>109</td>
<td>0.3</td>
</tr>
<tr>
<td>½ banana, medium, raw</td>
<td>63</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Snack</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 c. popcorn, cooked with oil</td>
<td>82</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,999</td>
<td>71.1</td>
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Protein allowance one-third above 1980 recommendation of the National Academy of Sciences (44 grams)

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<td></td>
</tr>
<tr>
<td></td>
<td>2,000</td>
<td>59</td>
</tr>
</tbody>
</table>
Genetic differences may play a role not only in our needs but also in our taste for foods (which may or may not be related to needs). In a recent study, adult identical twins were found more similar in their choices of foods, including the protein density of the diet, than were fraternal twins.3

**Effects of Stress**

Even more surprising, any individual’s need for protein can vary a lot. Physical stress—pain, for example—or psychological stress—even from exam pressure—can push your protein need up by as much as one-third. But remember, most of us eat almost twice the protein our bodies can use, so we can easily get the “extra” protein needed under stress from the protein already in most of our diets.

A World Health Organization report4 discussed these stress conditions: (1) heat: unacclimatized individuals lose nitrogen (a primary component of protein) in heavy sweating; (2) heavy work: athletes and others may need additional protein when they are increasing their muscle mass, although the amount needed is not likely to be large (some studies, though not widely substantiated, suggest an additional 25 percent intake over the totals recommended here if you are building muscle mass); (3) inadequate energy intake: when overall calorie intake is not adequate, some dietary protein is used for energy and thus is not available to meet protein needs; (4) infection: infections, especially acute ones, cause some depletion of body nitrogen due to increased urinary excretion and poor intestinal absorption (as with diarrhea); these losses need to be replaced with additional protein during recovery.

The obvious conclusion is this: we should suspect any diet “expert” who claims that we all would do better on a high-protein or a low-protein diet. Instead of following a recommended allowance blindly, we should become better observers of our own body’s well-being, developing what protein researcher Williams calls “body wisdom.” Part of body wisdom is being aware of how you feel—your energy level, general health, and temperament. (Certain
nutritional deficiencies negatively affect appetite and choice of foods, so just feeling “satisfied” is not enough.) Body wisdom also involves being a wise observer of your body’s condition: many types of nutritional deficiencies show up as deterioration in the hair, skin, and nails and in the slow healing of wounds.

Why Do We Need Protein Anyway?

Given protein’s importance to the body, perhaps it is not so surprising that a certain mystique grew up around it. We simply cannot live on fats and carbohydrates alone. Protein makes up about one-half of the nonwater components of our bodies. Just as cellulose provides the structural framework of a tree, protein provides the framework for animals. Skin, hair, nails, cartilage, tendons, muscles, and even the organic framework of bones are made up largely of fibrous proteins. Obviously, protein is needed for growth in children. Adults also need it to replace tissues that are continually breaking down and to build tissues, such as hair and nails, which are continually growing.

But talking about the body’s need for “protein” is unscientific. What the body needs from food are the building blocks of protein—amino acids, specifically the eight that the body cannot manufacture itself, which are called “essential amino acids.” Even more precisely, what the body actually requires are the carbon skeletons of these essential amino acids that the body cannot synthesize, although it can complete them by adding nitrogen, if the nitrogen is available. The body needs many more amino acids than just these eight essential ones. The body can, however, build the others if it has sufficient “loose” or extra nitrogen to build with. Thus, what is popularly referred to as the “protein” the body needs to eat are the eight essential amino acids and some extra nitrogen.

The body depends on protein for the myriad of reactions that we call “metabolism.” Proteins such as insulin, which regulate metabolic processors, we call “hormones”; other proteins, catalysts of important metabolic reactions, we call
"enzymes." In addition, hemoglobin, the critical oxygen-carrying molecule of the blood, is built from protein.

Not only is protein necessary to the basic chemical reactions of life, it is also necessary to maintain the body environment so that these reactions can take place. Protein in the blood helps to prevent excess alkalinity or acidity, maintaining the "body neutrality" essential to normal cellular metabolism. Protein in blood serum participates in regulating the body's water balance, the distribution of fluid on either side of the cell membrane.

Last, and of great importance, new protein synthesis is needed to form antibodies to fight bacterial and viral infections.

How Much Is Enough?

The protein allowances I use in this book are those recommended by the Committee on Dietary Allowances of the National Academy of Sciences, Food and Nutrition Board. It's interesting to learn how the committee arrives at these recommended allowances. Keep in mind that the procedure is full of assumptions (some of which are disputed within the scientific community), estimates, and averages. Realizing this, R. J. Williams's advice takes on even greater importance: observe your own body carefully to find out what is best for you.

To come up with the recommended allowance for an entire population, the committee followed four steps:

Step 1. Estimating average need. Since nitrogen is a characteristic and relatively constant component of protein, scientists can measure protein by measuring nitrogen. To determine how much protein humans need, experimenters put subjects on a protein-free diet. They then measure how much nitrogen is lost in urine and feces. They add to this an amount to cover the small losses through the skin, sweat, and internal body structure. For children, additional nitrogen for growth is added. The total of these nitrogen losses is the amount you have to replace by eating protein, and is therefore the basis of the average protein requirement for
body maintenance—24 grams of protein for a 154-pound man (also expressed as .34 gram of protein per kilogram of body weight).

**Step 2. Adjusting for individual differences.** To allow for individual differences and to cover 97.5 percent of the population, the committee sets this protein requirement 30 percent above the average, arriving at 30 grams per day of protein for a 154-pound man, or .45 gram per kilogram of body weight per day. This assumption that 30 percent above the average requirement will cover 97.5 percent of the population is one of the issues in dispute by nutritionists.

**Step 3. Adjusting for normal eating compared to experimental conditions.** Scientists have discovered that protein is used less efficiently when people are eating a normal diet containing some extra protein than when they are eating at or near their protein requirement, as they do under experimental conditions. Apparently, when people are deprived of protein their bodies compensate by more fully using what’s there and excreting less. So to account for the less efficient use of protein in ordinary eating patterns, the committee adds another 30 percent. This brings the allowance up to 42 grams for a 154-pound “average” American man, .57 gram per kilogram of body weight per day.

**Step 4. Adjusting for protein usability.** The protein in our food is not fully used by the body. The above estimates are all based on an ideal “reference protein” (I’ll explain this fully in the following section). Scientists estimate the average usability of protein in the U. S. diet at 75 percent. Therefore, the allowance of 42 grams of protein for a 154-pound male is pushed up to 56 grams because it is assumed that only 75 percent of what is eaten is actually used. For a 128-pound woman, the average American female, the corresponding allowance is 44 grams.

So now you know how the National Academy of Sciences arrived at the recommended protein allowances that are used throughout this book. Since it is set 30 percent above the average, it is more than most people need. Some protein authorities, however, believe that the allowance still may not be high enough to include 97.5 percent of the population.
Special Needs

While I've said that protein complementarity is not necessary for most of us, it does come in handy for those who must increase their protein intake without increasing calories. This is true for those whose bodies are under special stress, especially pregnant and breast-feeding women. A pregnant woman is advised to up her protein intake by an additional 30 grams a day (a 68 percent increase) but her calorie intake by only 300 calories (a 15 percent increase). A breast-feeding woman is advised to add 20 grams of protein to her diet but only 500 more calories; that would be 45 percent more protein but only 25 percent more calories. With these high protein needs, it becomes important to make the most of all the protein you eat, and combining complementary protein can help do that.

Many are concerned about the protein needs of children. Actually, they do not need more protein in relation to their calorie intake than adults. But because infant and young children cannot digest certain plant foods as easily as adults, some special care is needed in meeting their needs on a largely plant food diet. Michael and Nina Shandler have provided guidance for parents in *The Complete Guide and Cookbook for Raising Your Child as a Vegetarian* (Schocken Books, 1981). It also contains sound nutritional advice for pregnant women.
4.

Protein Complementarity: The Debate

In the previous chapter I tried to dispel the myth that you need lots of meat to get the protein you need, while confessing that *Diet for a Small Planet* had helped create a new myth—that to get the protein you need without meat you have to conscientiously combine nonmeat sources to create a protein that is as usable by the body as meat protein. Protein complementarity is not the myth; it works. The myth is that complementing proteins is necessary for most people on a low- or nonmeat diet. With a healthy varied diet, concern about protein complementarity is not necessary for most of us.

Nonetheless, for several reasons, I would like to explain briefly protein complementarity. The first reason is that it is useful for people with a considerably higher than average protein need, including pregnant and breast-feeding women. Second, understanding protein complementarity does disprove any notion that animal protein is uniquely qualified to meet nutritional needs. But perhaps my real reason is simply that it fascinates me, particularly since I realized that complementary protein combinations evolved spontaneously as the basis of virtually all of the world’s great cuisines.

If all proteins were the same, there would never have been a controversy about preferable sources for humans;
only quantity would matter. Proteins, however, are not identical. The proteins which our bodies use are made up of 22 amino acids in varying combinations. As already noted, 8 of these amino acids cannot be synthesized by our bodies; they must be obtained from outside sources. These 8 essential amino acids (which I will refer to as “EAAs”) are tryptophan, leucine, isoleucine, lysine, valine, threonine, the sulfur-containing amino acids (methionine and cystine), and the aromatic amino acids. (Histidine is also necessary for children.)

Our bodies need all of the EAAs simultaneously in order to carry out protein synthesis. If one EAA is missing, even temporarily, protein synthesis will fall to a very low level or stop altogether. We also need the EAAs in differing amounts. In most food proteins all of the EAAs are present, but one or more of the EAAs is usually present in a disproportionately small amount, thus deviating from the most utilizable pattern. These EAAs are called the “limiting amino acids” in a food protein.

Let us put together these three critical factors about protein:

Of the 22 necessary amino acids, there are 8 that our bodies cannot make but must get from outside sources.

All of these 8 must be present simultaneously.

All of these 8 must be present in the right proportions.

What does this mean to the body? A great deal. If you eat protein containing enough tryptophan to satisfy 100 percent of the utilizable pattern’s requirement, 100 percent of the leucine level, and so forth, but only 50 percent of the necessary lysine, then as far as your body is concerned, you might as well have eaten only 50 percent of all the EAAs. Only 50 percent of the protein you ate was used as protein. The protein “assembling center” in the body cells uses the EAAs at the level of the “limiting amino acid”; that is, at the level of whichever EAA happens to be least present. The surplus amino acids are released to be used by the body as fuel as if they were carbohydrates. Figure 12 gives you a graphic illustration of what this means.

One reflection of how closely the amino acid pattern of a given food matches that which the body can use is what nutritionists term the “biological value” of a food protein.
Roughly, the biological value is the proportion of the protein absorbed by the digestive tract that is retained by the body. In other words, the biological value is the percentage of absorbed protein that your body actually uses. There is, however, another question: how much gets absorbed to begin with by the digestive tract? That is what we call “digestibility.” So the protein available to our bodies depends on its biological value and its digestibility. The term covering both of these factors is “net protein utilization,” or NPU. Quite simply, NPU estimates how much of the protein we eat is actually available to our bodies. (See Figure 13.)

The NPU of a food is largely determined by how closely the essential amino acids in its protein match the body’s one utilizable pattern. Because the protein of egg most nearly matches this ideal pattern, egg protein is used as a model for measuring amino acid patterns in other food. The amino acid pattern of cheese nearly matches egg’s pattern, while that of peanuts fails utterly. You can guess then that the NPU of cheese is significantly higher than that of peanuts. The difference is great—70 as compared to about 40.

In Appendix D I provide basic protein information on over a hundred commonly eaten foods. I give the amount of usable protein (total protein adjusted by NPU scores), their amino acid strengths and weaknesses, and the contribution of one serving to meeting an average person’s daily protein allowance.

In the last few years, nutritionists have learned that the NPU ratings (see Appendix C) tend to overestimate the usability of protein by the body; that is, the NPU values we use are too high. Most of these ratings were determined in experiments in which people’s protein intake was grossly inadequate. At this low level, it turns out, the body uses protein more efficiently than when the diet contains adequate protein. This is especially true for the less usable plant proteins. What this means is that in a protein-adequate diet, we may have to eat slightly more of any given food to get the amount of usable protein indicated. Scientists are now proceeding with experiments based on this new understanding, but in the meantime, all we have are the current NPU scores.
This amount of protein in the food becomes... …this amount of protein for your body to use.

Figure 12. The Problem of a "Limiting Amino Acid"

Figure 13. What Is "NPU"?
Figure 14. The Food/Protein Continuum

Quantity of Protein
(Percent) Protein

Usability of Protein
Net Protein Utilization

Eggs 100
Milk 90
Fish 80
Cheese 70
Meat & Poultry
LEGUMES
Soybeans 60
Nuts & Seeds
Sunflower 50
Cashews
Sesame 40
Walnuts
Peanuts 30
MEAT & POULTRY
Chicken 20
Turkey
Beef & Pork
Hamburger
Lamb Chop
Swiss, American,
& Cheddar
Cottage
Parmesan
Cheese
NUTS & SEEDS
Soybeans
Peanuts
Sunflower seeds
FISH
Tuna
Cod
Eggs 10
Oats 9
Rice 8
Yogurt
Milk & Yogurt
Brown rice 7
Oats 6
Wheat 5
Polished rice 4
Cornmeal 3
Cheese
Grains
Brown rice
Oats
Wheat
Polished rice
Cornmeal

Source of Data: Department of Agriculture Handbook No. 8, 1968; and The Amino Acid Composition and Biological Value of Some Proteins,
This discovery does not call into question the perspective put forth here. It has been taken into account in setting protein allowances.

Is Meat Necessary?

Those who insist on the superiority, or indispensability, of meat as a protein source focus on both the large quantity and the high quality of protein in meat. Plant protein is seen as inferior on both counts. The result is that animal and vegetable protein are thought of as comprising two separate categories. In fact, this is a common mistake in our thinking about protein. It is much more useful and accurate to visualize animal and vegetable protein along a continuum.

Figure 14, "The Food/Protein Continuum," will help you see the range of protein variability on two scales: protein quantity, based on the percent of protein in the food by weight; and usability, based on the NPU of the protein. (Weights for grains and legumes are calculated for cooked food.)

*Quantity*. When judging foods with the percentage of protein as the criterion, generalization is difficult. It is clear, however, that plants rank highest, particularly in their processed forms. Soybean flour is over 40 percent protein. Next come certain cheeses, such as Parmesan, which is 36 percent protein. Meat follows, ranging between 20 and 35 percent. Cooked beans, peas, and lentils have between 5 and 10 percent protein; though it might surprise you, eggs, milk, and yogurt are in the same range. There are, of course, other plants—some fruits, for example—that contain too little protein to even appear on the scale. (We are concerned here only with plants that are widely used as sources of protein.)

Warning: this quantity scale is misleading. It gives the

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FAO, Rome. Courtesy of Dr. Isabel Contento, Department of Nutrition Education, Teachers College, Columbia University; adapted from chart in 1971 edition of *Diet for a Small Planet*. 
percent by weight, yet the real issue in evaluating a protein source is not weight but calories. Can we get enough protein from a food without getting too many calories? Looked at from this angle, most plant foods qualify and some excel. Eating vegetables such as broccoli, cauliflower, mushrooms, and spinach, you get the same amount of protein for each calorie that you get with meat. But it would be difficult to get a full day's protein allowance from cauliflower (unless you were prepared to eat 20 cups!). Nonetheless, such vegetables can contribute substantially to meeting our protein needs.

Usability. The protein usability scale generally ranges from NPU values of about 40 to 94. Clearly, animal protein occupies the highest rungs of this scale. Meat, however, is not at the top. It places slightly above the middle, with an average NPU of 67. At the top are eggs (NPU of 94) and milk (NPU of 82). The NPUs of plant proteins generally range lower on the continuum, between 40 and 70. But protein in some plants, such as soybeans and whole rice, approaches or overlaps the NPU values for meat.

Complementing Your Proteins

Because different food groups have different amino acid strengths and weaknesses, eating a mixture of protein sources can increase the protein value of a meal; here's a case where the whole is greater than the sum of its parts. The EAA deficiency in one food can be countered by the EAA contained in other food. For example, the expected biological value of three parts bread and one part cheddar cheese would be 64 percent if eaten separately. Yet, if eaten together, their biological value is 76 percent because of the complementary relationship. The "whole" is greater largely because cheese makes up for bread's lysine and isoleucine deficiencies. Such protein mixes do not result in a perfect protein that is fully utilizable by the body (only egg is near perfect). But combinations can increase the protein quality as much as 50 percent above the average of the items eaten separately.
Figure 15. Demonstrating Protein Complementarity

Key amino acids

**BEANS** alone

Level of amino acids in egg protein

**LYS**

**SC**

**TRY**

**WHEAT** alone

DEFICIENCY

STRENGTH

BEANS + WHEAT = COMPLEMENTARY PROTEIN COMBINATION

Eating wheat and beans together, for example, can increase by about 33 percent the protein actually usable by your body. Figure 15 will help you see why. It shows the four essential amino acids most often deficient in plant protein. On each side, where beans and wheat are shown separately, we see large gaps in amino acid content as compared to egg protein. But if we put the two together, these gaps are closed.

Figure 16, "Summary of Complementary Protein Relationships," illustrates the basic combinations of foods whose proteins complement each other. The dishes listed are meant to be suggestive of the almost endless possibilities using each combination. (Complete protein tables are in Appendix E.)

The Complementarity Debate

Since the first edition of *Diet for a Small Planet*, many have pointed out that it is not really necessary to eat complementary proteins *in the same meal*, as I implied. They are right, technically. But experimental evidence suggests that protein assembly will slow down after several hours if all of the amino acids are not present. "If a diet lacks only one essential amino acid, which is provided several hours later, efficient use of all amino acids falls," says a National Academy of Sciences report. So it would seem that unless we eat more than three meals a day, the only way to ensure protein complementarity is to eat complementary proteins in the same meal.

In 1972, E. S. Nasset reported evidence of an "amino acid pool" that could make up for any deficiencies in the amino acid patterns of the food we eat. Nasset's work has been cited by many to suggest that eating complementary proteins may be irrelevant. But most nutritionists disagree with Nasset. His amino acid pool theory "has been questioned by a number of workers and the results presented so far do not support Nasset's theory," reports a 1978 study. This view is confirmed by MIT's Nevin Scrimshaw, a
breads with added seed meals
breads with sesame or sunflower seed spread
rice with sesame seeds

rice-bean casserole
wheat-soy bread
lentil curry on rice
corn-soy bread
wheat bread with baked beans
bean or pea curry on rice
corn tortillas and beans
pea soup and toast
legume soup with bread

Mean complementary relationship is demonstrated only between a few items in each group.

Means complementary relationship is more generally confirmed between several items in each group.

**Figure 16. Summary of Complementary Protein Relationships**
member of the group that sets the UN’s recommended protein allowances: “The Nasset Hypothesis is fallacious in that it applies only to the amino pattern in the intestine and not the overall amino acid turnover of the whole body.” Scrimshaw adds, “It is necessary to eat complementary protein within three to four hours.”

In sum, then, here is what I have learned about protein in the last 10 years:

● To obtain more usable protein we don’t have to eat complementary proteins in the same meal, if we have frequent meals. But doing so seems to be convenient and easy, since so many dishes combine complementary proteins anyway.

● For effective protein use, however, we do need to eat complementary proteins within a few hours of each other.

● For most people, even those eating strictly a plant food diet, attention to complementary proteins is not necessary as long as the diet is healthy otherwise. Exceptions include pregnant and breast-feeding women; they must increase their protein more than their calories.

● No one should accept blindly the recommended protein allowances. Variations in protein need among individuals are so great that we must pay close attention to our need for more or less protein, observing both our overall sense of well-being and such danger signs as poor healing and unhealthy hair or nails.

● Presently available NPU ratings, such as those used in Appendix E to show the percentage of usable protein in foods, probably overestimate available protein. But since most people eat at levels above the recommended allowances, even without meat, this is generally no problem.