Pirie, N. W. 1967. Protein metabolism. *Proceedings of the Royal Society Medicine.* 60 (11 Pt 1), pp. 1065-1066.

Section of Experimental Medicine and Therapeutics

President A S V Burgen MD

Meeting January 10 1967

Protein Metabolism

Dr N W Pirie
(*Rothamsted Experimental Station, Harpenden, Hertfordshire*)

World Protein Supplies
[*Summary*]

Food, averaged over a few days, must contain from 12 to 20% of protein (as dry matter) and one cannot meet a daily protein need merely by eating more of a low-protein food. This means that, if people are getting a diet that is supplying enough calories in such forms as potatoes and the cereals (with 7 to 11% protein), they will be getting about half the necessary protein. But increased consumption of these foods is not a satisfactory way of getting the remainder of the protein. Supplements containing 25% or more protein are needed. It is these supplements that are meant in discussions about protein supplies and they are now the most difficult parts of a diet to produce.

Meat and other animal products are the cardinal supplements in the well fed countries. Most of the world's inhabitants get a tenth or less the amount that we eat and it is very unlikely, in spite of commendable efforts to control disease and to use as food a more extended range of animals, that production can be so expanded that our dietary habits can become universal. It is more likely that we will in future have to rely less on animal products. Similarly, fish is a major protein source for 5% of the world's population only, and the catch could probably not be more than trebled. A larger proportion of it should, however, be used as food rather than fodder. Shortage, cost and prejudice are therefore likely to limit dependence on animal protein and force us to give more serious attention to vegetable sources. Green vegetables, immature flowers (cauliflower and broccoli), and the legume seeds are important in many parts of the world and they could be used much more extensively, but it is unlikely that these alone will satisfy the need.

After the oil has been expressed, groundnuts, soya beans and cotton seed leave a residue containing 40–50% protein. At present these are mainly used as cattle fodder or even fertilizer but, if care is taken in harvesting and processing, they are palatable and nutritious. Methods have been devised in Central America, India and Japan for using these residues and they are gradually gaining acceptance.

Coconut residue contains only 20% protein and has so much fibre that it can be eaten only sparingly. Before it can be used extensively the protein must therefore be extracted. There are traditional ways of doing this on a kitchen scale and attempts are now being made in India and the Philippines to extract coconut protein on a large scale.

Leaves present a similar problem. They contain 15–25% protein of good biological value, but it is accompanied by so much fibre that they cannot be eaten directly in large amounts. After pulping the fresh leaves, pressing out the juice and coagulating it, the protein can be filtered off. Equipment for doing this on a large scale has been developed during the last fifteen years at Rothamsted, and elsewhere, and used on leaves of many different species. Ideally, leaves that are a by-product from some other crop, e.g. banana, jute, ramie, sugar beet, sugar cane, sweet potato, or peas and beans harvested for canning or freezing, would be used for they are at present largely wasted. Once the idea of using leaf protein as a human food is accepted it would, however, be reasonable to grow crops specially for this purpose because a greater yield of protein would be got from an acre in a year in this way than by conventional agriculture.

These processes of extraction and separation will yield soluble and insoluble by-products. They could be used as fodder but it is probably more efficient to use them as microbial substrates. Furthermore, micro-organisms can be grown on other carbon sources such as coal, oil, and

natural gas. There are great potentialities in this for there are enormous supplies of raw material and they are conveniently concentrated so that efficient factory production is possible. It must, however, be borne in mind that the primary need at present is for local production of protein from locally available sources rather than for further supplies of protein that have to be imported from wealthy countries.

The idea of using microbial protein as a bulk food is new. So is the texture of the product. The most valuable feature of the interest now being taken in microbial protein is that it will familiarize people with the idea of using novel protein sources. There should be no competition between those working on seed, leaf, microbial or any other type of protein; all will be needed and their use will call for vastly extended work in the kitchen on methods for making them acceptable.

Mr D S Miller
(Queen Elizabeth College, London)

Protein Requirements

The trouble with the title of this paper is that it is open-ended. It neither says requirements for what, nor does it say what sort of protein, and because these two words are badly defined it is not surprising that when the subject is examined historically it is found there has been an enormous range of recommended allowances.

The early German workers believed, for very little reason, that high protein intakes were necessary for health, and, for instance, a hundred years ago Voit recommended 120 g protein per head per day. These views were still currently held at the time of the 1914 war, and it is frequently claimed by nutritionists that the Germans lost the war as a result of being advised wrongly that meat was an essential food for the fighting soldier; they concentrated on animal husbandry in the face of the blockade, thus lowering the efficiency of their agriculture and starving the nation. Between the wars, protein requirements tended to be based on what protein was eaten by the countries in the west; this led the League of Nations to recommend 1 g per kg body weight per day, and the British Medical Association to recommend that 10–14% of the calories should be derived from protein. However, during this period there was strong support in America for much lower protein intakes, on the basis of nitrogen balance data. This school was initiated by Professor Russell Chittenden who believed in low protein diets and recommended 40 g per day, and this was supported later by W C Rose who established which of the amino acids were essential for man and that it was possible to maintain nitrogen balance on the equivalent of 20 g protein per day.

However, it is not simply the difficulty of deciding what is meant by the word requirements; one must also consider that the word protein covers materials which have widely different qualities. Historically most of the recommended allowances specify that half the protein should be derived from animal sources, in the belief that these are of superior quality to plant proteins. The belief is only partly true since there are some plant proteins which are superior to some animal proteins. Proteins differ in quality because they have different amino acid patterns. For a man, there are eight essential amino acids which are not synthesized sufficiently fast for requirements and must therefore be supplied in the diet. The non-essential amino acids are of course essential constituents of muscle but can be synthesized from other nitrogen sources.

The historical background shows that the best criterion for protein requirements is maintenance of nitrogen equilibrium, at least with adults. Nitrogen requirements for growth and lactation must be included where appropriate. These criteria for adequacy are in terms of the amount of nitrogen that must be retained, but before one can convert these amounts into dietary requirements one must examine all those factors that influence the efficiency of nitrogen utilization. The first question, however, is how much nitrogen is needed for nitrogen equilibrium. Traditionally this is found by determining the endogenous nitrogen loss, i.e. urinary nitrogen loss when no nitrogen is fed. This has been shown to be approximately equal to 2 mg nitrogen per basal calorie, and is the major nitrogen loss from the body: to it must be added losses in the fæces, sweat, hair and skin. The total has been estimated as 250 mgN/day/kg$^{3/4}$ and for a 70 kg man this amounts to 32 g protein/day. People sometimes doubt that it is possible to maintain nitrogen equilibrium on such a low protein intake, but many millions of people must be eating this, and certainly Chittenden existed on this for half of his lifespan. It is a matter of debate whether he lived to the ripe old age of 88 because of or in spite of his diet.

Protein requirements for growth are more difficult to assess because it is necessary to know how fast children should grow. It is usual to assume that the growth of American children is the ideal, but there is behind this assumption the