Factors Affecting Haemoglobin Biosynthesis

By T. HUNT, A. HUNTER and A. J. MUNRO.
(Department of Biochemistry, University of Cambridge)

In rabbit reticulocytes iron deficiency causes depression of protein synthesis and a breakdown of polysomes. The effects of amino acid starvation are more complex. In all cases there is a depression of protein synthesis but only in some cases are changes in the size of the polysome observed. These findings prompted us to compare certain of the parameters that describe the synthesis of α - and β -chains of haemoglobin in normal and deprived reticulocytes. We have measured the relative numbers of ribosomes making each chain, the size of the polysomes involved in the synthesis of each chain, the distribution of the ribosomes on the α - and β -chain messenger-RNA classes, and the rate of movement of ribosomes along the two different classes of messenger RNA.

Our experiments show that under normal conditions, the rate of translation of the α -chain messenger RNA is approx. 1.3 times that of the β -chain messenger RNA, and the polysomes synthesizing α -chains are smaller on average than those synthesizing β -chains. Further, as far as can be measured, the distribution of ribosomes is uniform along both classes of messenger RNA. From these results we argue that the overall rate-limiting step in α - and β -chain synthesis is not the terminal step of protein synthesis, but is probably the initiation process of chain assembly. Under special conditions, however, the rate-limiting step might be the assembly process itself. The rate of movement of ribosomes down the messenger RNA is not governed by a general step of protein synthesis, since it is affected by the sequence of nucleotides being translated. This control could operate through the availability of specific aminoacyl transfer RNA types, and starvation of particular amino acids can be shown to cause alteration in the balance of α - and β -chain synthesis. For instance, starvation of threonine (which residue occurs 11 times in the α -chain and four times in the β -chain) causes an increase in the time taken to translate the α -chain relative to the β -chain. On the other hand our results and those of other workers suggest that haem or iron deficiency affects initiation of new chains and not the rate of movement of ribosomes as has previously been suggested.

From the translation time and the number of ribosomes engaged in the synthesis of each chain it is possible to calculate the number of molecules of each chain made in unit time. Since there appear to be nearly equal numbers of ribosomes making α - and β -chains, it follows that there is a continuous production of a small excess of α -chains relative to

β -chains. This surprising result is compatible with the existence of an α -chain pool in reticulocytes. These findings will be discussed in connection with the control of the assembly of haemoglobin in rabbit reticulocytes.

Complementary Ways of Meeting the World's Protein Need

By N. W. PIRIE. (*Rothamsted Experimental Station, Harpenden, Herts.*)

In spite of improvements in the methods of contraception, and increasing acceptance of it, there may be 7×10^9 people in the world by the end of the century. People can obviously exist on 40 g. of protein/day, and on that amount nitrogen balance may be attained, but there is reason to think that they would fare better if they got more, perhaps as much as 100 g./day. The world protein requirement could therefore be 256×10^6 tons/year. The amount now eaten by people is 90×10^6 tons, and a 20×10^6 ton deficit is officially recognized. New sources of protein are needed immediately and the need is likely to become still greater soon. This need will be most effectively met by proteins made by simple processes near the place where the protein will be eaten.

The new high-yielding varieties of cereal will do much to meet the need, especially if the promise of strains with enhanced protein content is borne out. So will increased use of traditional legumes and green vegetables. These deserve much more attention from plant breeders than they get. More fish could be caught, but this source is unlikely to meet more than 5% of the need. Domestic animals are valuable so long as they are not maintained on food that people could have eaten or on fodder grown on arable land. It is not certain that the species now used are ideal in all environments, and in some regions it might be advantageous to use a mixture of species to crop heterogeneous uncultivated herbage.

Cotton-seed, ground-nut and soya-bean contain protein that is now very inadequately used. The residue left after extraction of oil from these seeds is eaten on a small scale in several countries. Much less work has been done on the nutritionally more valuable proteins that can be extracted from coco-nuts and leaves. The yield of leaf protein/acre is as great as the yield from any other source and the potential supply is enormous. It is a pity there is not more work on coconuts and leaves because they grow particularly well in the wet tropics; that is where the most acute protein deficiency exists. There is active research on the use of micro-organisms, grown on various fossil fuels, as food and