Factors Affecting Haemoglobin Biosynthesis

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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

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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

fodder, but the technology of this process is intricate. The product may not, therefore, reach those most in need, but the enterprise that is being shown should promote interest in the growth of micro-organisms on low-protein crops and on by-products such as molasses and straws.

Work on the production of novel proteins is hampered by the indifference or even hostility of

national and international bodies responsible for our food supplies. It will be still further frustrated unless serious effort is put into studies on the presentation and popularization of novel forms of food. This work will call for skill, tact and a broad-minded recognition of the diversity and irrationality of traditional human tastes. It is this aspect of the problem that is now in most need of support.

COMMUNICATIONS*

The Fatty Acid Composition of Adipose and Muscle Tissue in Domestic and Free-Living Ruminants

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The fatty acid composition of muscle tissue from free-ranging (*Syncerus caffer*) and domestic bovids (*Bos taurus*) differs considerably. In the free-ranging bovids there is a small amount of intramuscular fat, which contains a high proportion of polyenoic fatty acids compared with domestic bovids (Crawford, 1968). We have examined the fatty acid composition of adipose and muscle tissue of samples from free-ranging and domestic ruminants and in both cases the degree of polyunsaturation was greater in muscle than in adipose tissue.

In adipose tissue from domestic bovids the monounsaturated fatty acids dominated, accompanied by small amounts (0.2–2%) of polyenoic fatty acids. In associated muscle tissue there was a greater amount of polyenoic fatty acids, including eicosatetraenoic acid; the total proportion of polyenoic fatty acid was 0.8–6% and, as in the adipose tissue, the monounsaturated fatty acids predominated, in agreement with the findings of Hubbard & Pocklington (1968).

The adipose tissue of the free-ranging ruminant contained about 2–6% of polyenoic fatty acids including octadecadienoate and octadecatrienoate; the saturated and monounsaturated fatty acids predominated. In contrast, the muscle tissue of the free-ranging ruminants contained about 20–40% of polyenoic fatty acids including octadecadienoate, octadecatrienoate, eicosatetraenoate, eicosapentaenoate, docosapentaenoate and docosahexaenoate. The fact that in neither case did the adipose tissue contain significant amounts of polyenoic fatty acids higher than C_{18:3} suggests that the composition of adipose tissue may not reflect the proportions that are available in other tissues.

* Other communications are published in the Proceedings of the Nutrition Society (1969) **28**, No 2.

The wide difference in the adipose- and muscle-tissue fatty acid composition in the free-living animal suggests an efficient separating mechanism for structural lipids (predominantly phospholipid) and adipose depots for energy stores (predominantly triglyceride). The smaller differences between adipose and muscle tissue of domestic animals might be explained on the basis of infiltration of adipose fat, which may represent a biologically abnormal state.

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Immunoglobulins in Sow Mammary Secretions throughout Lactation and their significance as Anti-(*Escherichia coli*) Antibodies to the Young Pig

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Under normal conditions piglets cease to absorb immunoglobulins from the colostrum after the first 24–36 hr. of life (Lecce & Morgan, 1962). The animal does not synthesize any appreciable amount of antibody before the age of 3–4 weeks (Brown, Speer, Quinn, Hays & Catron, 1961; Miller *et al.* 1962) and passively acquired antibody falls to very small amounts in the period 2–3 weeks (Sharpe, 1965; Arbuckle, 1968). It has often been suggested that antibodies in milk play an important role in protecting the young animal against enterobacteria. The protein composition of porcine milk changes rapidly in the early part of lactation (Morgan & Lecce, 1964), but nothing is known of the changes in specific immunoglobulins or their role as antibodies in the alimentary tract of the young pig.

Immunoglobulins G, A and M (IgG, IgA and IgM) were isolated from porcine serum and colostrum and antisera were prepared in rabbits for use as specific reagents for detection and quantitative measurement. The immunoglobulins account for more than