CHAPTER IV

SUMMARY

Although the chemical composition of the brain has been considered to be relatively stable, the high rate of turnover of brain proteins and the high incorporation of labelled glucose into glutamic acid in the brain suggest the active metabolic character of this organ. Protein deficiency has been found to result in histological changes in the brain of piglets.

Previous studies in this laboratory showed a decrease in the activities of certain cerebral enzymes and an impairment of psychological performance in rats subjected to a low protein diet. The enzyme changes were mainly with regard to L-glutamate:NAD-oxidoreductase and L-glutamate:1-carboxy-lyase, suggesting a possible change in the metabolism of glutamic acid.

The present investigations were designed to extend the above studies to other conditions of a similar kind. Studies were made of the effects of the following variables in rats on psychological performance and brain biochemistry. The enzymes studied were the ones mainly involved in the formation of glutamic acid from 2-oxoglutaric acid viz. L-glutamate:NAD-oxidoreductase, and oxidation of glutamic acid via Gamma-aminobutyric acid viz., L-glutamate:1-carboxy-lyase and 4-aminobutyrate:2-oxoglutarate aminotransferase.

One or other of the several measures such as performance on the Hebb-Williams maze, visual discrimination, water maze and avoidance of a foot shock was used as a psychological measure, the choice being made in accordance with the suitability of the measure for the conditions studied.

A low protein diet was found to decrease the activities of L-glutamate:NAD-oxidoreductase and L-glutamate:1-carboxy-lyase in the cerebrum confirming the results of previous studies in this laboratory. Addition of glutamic acid to a low protein diet was found to increase the activities of L-glutamate:NAD-oxidoreductase and L-glutamate:1-carboxy-lyase (Experiment I).

To study the effects of protein quality, groups of animals were fed a millet deficient in lysine and the same enriched with either lysine or foodstuffs rich in the amino acid such as legumes and skim milk powder. The group fed on the basal diet was found to perform worse on a water maze and has lower activities of L-glutamate:NAD-oxidoreductase and L-glutamate:1-carboxy-lyase as compared to groups supplemented with either lysine or lysine source. There was no significant difference between the groups receiving the different supplements (Experiment II).

The dietry improvement brought about by feeding pre-school children breakfast and lunch at a rural play centre was found to result in considerable nutritional improvement. This situation was simulated in the laboratory with rats and groups of animals were fed diets consumed by children not attending the play centre at home and by those getting breakfast and lunch at the centre and dinner at home. A third group was fed the diet provided at the centre. The experimental diet differed from the diet of the controls in that they had a higher proportion of legumes and peanuts and contained green leafy vegetables rich in carotene. The former was superior with regard to protein, calcium, ascorbic acid, riboflavin, carotene and other nutrients. This overall improvement of the diet was found to produce effects similar to those of a high protein diet, namely an increase in the activities of cerebral enzymes and improved psychological performance as tested on the Hebb-Williams maze. A significant increase was also found with regard to 4-aminobutyrate:2-oxoglutarate aminotransferase(Experiment III), in addition to that in L-glutamate:NAD-oxidoreductase and L-glutamate:1-carboxy-lyase.

In an experiment designed otherwise, the animals in all the experimental groups were found to show practically no gains in weight for about 13 weeks presumably due to

heat stress caused by high environmental temperatures prevailing at the start of the experiment. These animals were compared with stock animals not subjected to such prolonged growth arrest. Surprisingly, such prolonged growth arrest was not found to affect consistently either performance on visual discrimination and reversal learning or cerebral enzymes (Experiment IV). These findings have been confirmed by subsequent studies designed to assess the effects of early inanition.

Studies were made of the effects of electroconvulsive shocks to animals fed low and high protein diets on the avoidance of a foot shock and cerebral enzymes. Electroconvulsive shocks were found to result in an increased activity of 4-aminobutyrate:2-oxoglutarate aminotransferase, probably due to the destruction of an inhibitor as the animals were sacrificed almost immediately afterwards ruling out the possibility of de novo synthesis of the enzyme. The increase was of the same order in low and high protein animals. No differences were found between the two groups in avoidance of a foot shock (Experiment V).

In conclusion, the present studies show that the nutritional status of the animal affects both psychological performance and brain biochemistry. When considered with other observations of similar kind on the relation between nutrition and mental development in children, they must be considered to be of great practical significance.