Thiamine (T) plays an important role in glucose metabolism and the deficiency of T causes a decrease in glycolysis. A decrease or an increase in glycolysis may affect the T levels in blood (1). Ikehata (2) and Takagi (3) described that the average T levels of human blood were about 100 ng/ml, and these were decreased by intake of a carbohydrate rich diet or heavy exercise for several days. Takahashi (4) reported that the blood T levels were lower than the levels which had been reported about 30 years ago. He also suggested that low T levels seemed to be attributable to intake of polished rice, instant food, too high intake of coffee and cold beverages containing large amounts of sugar, and having an unbalanced diet. Murata (5) reported that T levels of self-boarding students cooking for themselves (they likely to have a less well balanced diet) were about 41±30 ng/ml. Therefore, the blood T levels seems to be changed by the turnover rate of glycolysis in the body.

In this paper, we examined the relationship between glucose and T levels in the blood from humans and rabbits, and made an experimental diabetes mellitus model in rabbits by the use of alloxan. Blood was taken early in the morning before intake of food from rabbits, healthy volunteers, and outpatients of the university hospital who were diagnosed as having diabetes mellitus (DM). Patients who took T preparations were excluded. For the experimental model, three male rabbits were injected with 150 mg/kg alloxan intravenously. Blood glucose levels were assayed by the methods of Kadish (6) and Fischl (7), and T levels were measured by a biological method using Lactobacillus viridescence (8).

There was a positive relationship (P<0.005) between T and glucose levels in human blood as shown in Fig. 1 (i.e. high blood glucose levels corresponded to high T levels). The average blood T levels were about 55 ng/ml, while they were about 58 ng/ml for individuals whose glucose levels
were above 101 mg/dl, and about 49 ng/ml for individuals with glucose levels below 100 mg/dl. The T levels of students who belonged to an athletic club were about 28 ng/ml, and these were about 50% lower than the average T levels, but they did not show any symptoms of T deficiency. In the case of rabbits, shown in Fig. 2, the average glucose levels were about 122 mg/dl and the T levels were about 212 ng/ml in the blood. Blood glucose levels were increased to 324 mg/dl, and blood T levels were increased to 280 ng/ml after administration of alloxan. T levels remained high in cases where the blood glucose was maintained at high levels, and in cases where glucose levels were gradually decreased, blood T levels were also gradually decreased. Comparing the appearance of the peak levels, the maximum T levels were seen at a later time than those of the glucose levels.

In DM, high blood T levels were observed as well as high blood glucose levels. Glucose and T are absorbed by active transport and sodium-dependent process from the small intestine (9, 10), and they are transported to red blood cells by facilitated diffusion without expenditure of metabolic energy (11). That is, the biodynamics of glucose and that of T seem to resemble each other. Blood glucose levels are due to glucose output from liver and utilization in other tissues, and increase in blood T levels in DM seems to be attributable to the increase in glucose output from liver and also the decrease in utilization in other tissues. As transport of T into hepatocytes requires metabolic energy (12), a decrease in ATP production by DM decreases T uptake into hepatocytes. Inoue has reported that endogenous T deficiency may be due to the decrease in contents of the active form of T (T-pyrophosphate=TPP) as co-enzyme (1). Increase in blood T levels in DM observed in this study may due to decrease in TPP levels (i.e. endogenous T deficiency).

Functional changes of peripheral nerves induced by alloxan in rats were inhibited by administration of large doses of vitamin B group compounds. The administration of insulin along with vitamin B was more effective than insulin used alone, and at that time of administration the T levels in the nerves seem to be decreased (13). The T deficient rats proved to have glucose intolerance, and it was attributable to the inhibition of insulin release from the pancreas (14).

T has been widely used for therapy or prevention of neuropathy in DM. The utilization of T seems to be lower in DM, so large doses of T administration probably increases the T and TPP contents of the

Fig. 2. Blood glucose and thiamine levels in rabbits after injection of alloxan (150 mg/kg). Same symbols indicate the same rabbits.
body. A lower rate of glycolysis causes a decrease in TPP, and this decrease in TPP contents may cause the inhibition of insulin release from the pancreas. This vicious cycle may be improved by administration of large doses of T.

We plan further studies to assay T levels in brain, heart, liver, kidney, pancreas, muscle and fatty tissues, and to assay TPP levels in tissues.

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