thyroxin dose was 0.1 mg. A daily dose of 30 vitamin $B_1$ units prevented loss of weight but permitted only little growth when the daily thyroxin allowance was 0.2 mg.

*Crystalline Vitamin $B_1$.* While 10γ (0.01 mg.) of crystalline vitamin $B_1$ seems to antagonize satisfactorily a 0.05 mg. thyroxin dose, complete protection against 0.1 mg. and 0.2 mg. thyroxin has not as yet been reached by as much as a 300γ (0.3 mg.) daily dose of crystalline vitamin $B_1$.†

Since 1 Sherman unit is equivalent to 2.5γ of crystalline vitamin $B_1$,[3] it has been possible for us to make observations on the biological value of the Lilly vitamin $B_1$ concentrate and the Merck's crystalline vitamin $B_1$, as indicated by unit doses. Since we are unable to secure the same increments of growth on higher doses of crystalline vitamin $B_1$ on our vitamin $B_1$ deficient diet[1] as Waterman and Ammerman,[3] and since there seems to be a supplementary relationship between the Lilly vitamin $B_1$ concentrate and the Merck's crystalline vitamin $B_1$, the evidence points to the existence of an essential component of the vitamin B complex for the mammalian organism other than vitamin $B_1$ and vitamin $B_2$ (the latter being furnished in abundance in our diet by 15% autoclaved beef),—possibly $B_4$, as originally suggested by Reader.[4]

8257 P

## Enzymic Efficiency in Avitaminosis.*

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In previous studies[1] we found that in vitamin B deficiency there is a marked reduction in the efficiency of digestion of pancreatic lipase but no demonstrable disturbance in the activity of either trypsin or erepsin. We have now completed considerable work with other enzymes in vitamin A as well as vitamin B deficiency. A pre-

† Since this material went to press, we have found that a sufficiency of yeast in the diet or administered separately from the ration will antagonize the toxicity of as high a daily dose of thyroxin as 0.2 mg. to the extent of 75 to 100 per cent.

[3] Waterman, R. E., and Ammerman, M., *J. Nutr.*, 1935, **10**, 38.

[4] Reader, V., *Biochem. J.*, 1929, **23**, 689; *Ibid.*, 1930, **24**, 77, 1827.

* Research paper No. 382, Journal Series, University of Arkansas, Fayetteville.

[1] Sure, B., Kik, M. C., and Buchanan, K. S., *J. Biol. Chem.*, 1935, **108**, 19.

liminary report at this time might, therefore, be of interest to other workers in this field.

The biological technique employed was the same as previously described.[1] The methods of titrating the enzymes were outlined recently.[2]

The results can be best presented by submitting summarized data in tabular form. Various stages of avitaminosis were studied. The following tables, however, represent general summaries of average results for all the different stages of vitamin deficiencies.

TABLE I.

% Changes† in Concentration of Various Blood and Tissue Enzymes in Vitamin $B_1$ Deficiency Compared with Litter Mate Controls of the Same Sex Restricted to the Same Diet and Same Plane of Nutrition.

| Enzyme | | No. of Groups | Enzyme | | No. of Groups |
|---|---|---|---|---|---|
| Pancreatic esterase | —40.5 | 18 | Bloom serum amylase | —9.7 | 17 |
| " lipase | —26.8 | 18 | Hepatic esterase | —1.1 | 17 |
| Hepatic lipase | —18.3 | 18 | Pancreatic amylase | —0.7 | 18 |
| Blood serum esterase | —13.3 | 18 | Blood serum phosphatase | +21.0 | 16 |

† + = increase, — = decrease.

TABLE II.

% Changes† in Concentration of Various Blood and Tissue Enzymes in a Deficiency of Vitamin B Complex Compared with Litter Mate Controls of Same Sex Restricted to Same Diet and Same Plane of Nutrition. (9 Groups Studied.)

| Enzyme | | Enzyme | |
|---|---|---|---|
| Pancreatic esterase | —42.2 | Pancreatic amylase | —2.5 |
| Pancreatic lipase | —19.7 | Blood serum phosphatase | +58.0 |
| Blood serum esterase | —14.2 | Hepatic lipase | +17.5 |
| Blood serum amylase | —6.5 | Hepatic esterase | +15.2 |
| Kidney phosphatase | —4.9 | | |

† + = increase, — = decrease.

TABLE III.

% Changes in Concentration of Various Blood and Tissue Enzymes in Vitamin A Deficiency Compared with Litter Mate Controls of the Same Sex Restricted to Same Diet and Same Plane of Nutrition.

| Enzyme | | No. of Groups | Enzyme | | No. of Groups |
|---|---|---|---|---|---|
| Blood serum esterase | —40.2 | 33 | Pancreatic lipase | —4.4 | 36 |
| Hepatic esterase | —15.6 | 36 | Pancreatic esterase | —2.2 | 35 |
| Blood serum amylase | —13.6 | 32 | Pancreatic amylase | —0.1 | 37 |
| Erepsin | —10.1 | 32 | Hepatic lipase | +35.0 | 35 |
| Blood serum phosphatase | —6.2 | 33 | Trypsin | +0.9 | 37 |

An examination of the tabular data discloses that the most marked changes in vitamin $B_1$ deficiency are decreases in pancreatic lipase and pancreatic esterase activity. In a deficiency of the vitamin B

[2] Sure, B., Kik, M. C., Buchanan, K. S., Thatcher, H. S., and DeGroat, A., *Biochem. J.*, 1935, **29**, 1508.

complex, in addition to considerable decrease in efficiency of pancreatic lipase and esterase, a pronounced increase in concentration of blood serum phosphatase was observed. In vitamin A deficiency the most outstanding feature is the large decrease in concentration of blood serum esterase and the increase in hepatic lipase.

In so far as the relation of vitamins to digestion is concerned, the only influence found to date is the marked decrease in efficiency of digestion of fats in vitamin $B_1$ deficiency. We found no disturbance in digestion of proteins or starches in either vitamin A or vitamin B deficiency.

8258 P

## Experimental Formation of Accessory Organs in Mid Body Lateral-Line of Amphibians.*

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The ability of primary lateral-line organs in amphibians to form accessory ones by budding,[1, 2] the time at which these bud organs are developed, and the pattern of organ groups gave a method for measuring the effects of the present experiments in amphibians.

When the placodes of the mid-body lateral-line primordia of young and older tail-bud stages of *Amblystoma punctatum* (Harrison stages 23-24 and 28-29) are exchanged, the age difference between graft and host organ-forming tissue can be clearly followed through the young larval stages by observing the time at which accessory organs are laid down by the budding of primary ones.

In *A. punctatum* the dorsal and ventral poles of primary organs give rise to accessory organs forming lineal groups of 2 or 3.[1] In *A. tigrinum* by a similar process groups of from 4 to even 8 are formed, usually in irregular clusters, as in *Rana palustris* and *Hyla crucifer*. There is multiple budding of both primary and accessory organs. When the mid-body lateral-line primordia are exchanged in the tail-bud stages of *punctatum* and *tigrinum* the formation and grouping of organs from the graft follow only that of the donor species.

* These studies were supported by financial aid from the Fluid Research Funds of the Yale University School of Medicine.

1 Stone, L. S., *J. Comp. Neur.*, 1933, **57**, 507.

2 Stone, L. S., PROC. SOC. EXP. BIOL. AND MED., 1934, **31**, 1082.