diet. The similarity in behavior of cones and rods in dark adaptation is obvious.

The black area means the return to a normal diet supplemented by 50,000 units of vitamin A per day. L. W. received 100,000 units in one day, but became ill for a few days following, during which he ate almost nothing and only resumed a supplemented normal diet later as indicated. The other two subjects merely returned to a normal diet without supplementary vitamin A. As Fig. 2 shows, there has been no spectacular return of visual function to normal on the resumption of regular and even excessive vitamin A consumption such as has been reported previously.[5, 7] There is a slightly rapid drop in threshold at first, but this gives way to a gradual decrease in threshold, and it may take longer to achieve complete recovery of function than it took to lose it.

For an understanding of the chemistry of vision, the significant thing is the almost parallel behavior of rod and cone thresholds during both the deficient and the recovery periods of the diet. This must mean that just as vitamin A enters into the chemical cycle of rod vision due to its association with visual purple, so it enters into the chemical cycle of cone vision, and that the cone sensitive substance[8]—iodopsin or visual violet—is very likely also a conjugated carotenoid protein like rhodopsin and porphyropsin.

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NEW OBSERVATIONS ON THE VITAMIN K DEFICIENCY OF THE CHICK

IN view of the interest shown in vitamin K by biologists and clinicians, it is believed that recent observations made in this laboratory should become available to other investigators.

It was found that vitamin K will bring about a normal clotting time of the blood of the vitamin K-deficient chick within from 4 to 6 hours after oral administration by pipette and that the blood clotting time of the chick will become abnormally long again within a short time, depending upon the amount of vitamin K administered.

Chicks were reared on a vitamin K-low diet for 3 days, then on the vitamin K-deficient diet E of Almquist and Stokstad[1] for from 10 to 16 days. When the typical hemorrhagic diathesis had appeared, the chicks were fed 0.20 ml of cod liver oil containing 1 mg of vitamin K concentrate No. 13[2] prepared from alfalfa. At 2 hours' intervals after the administration of the concentrate, the blood-clotting time of the chicks was determined by the method of Almquist and Stokstad.[3]

The blood-clotting time was found to be more than 30 minutes after 2 hours; after 4 hours, the blood of about 50 per cent. of the chicks clotted within 10 minutes; and after 6 hours practically all the chicks were normal with respect to coagulation.[4]

The coagulation time of chicks which had received 1 mg of the vitamin K concentrate remained normal for more than 24 hours; at the end of the second day, the blood of about 50 per cent. of the chicks no longer clotted within 30 minutes; and at the end of the third day, all the chicks had an abnormally long coagulation time.

No change was observed in the blood-clotting time of chicks which had received 0.25 mg of vitamin K concentrate No. 13 dissolved in 0.20 ml of cod liver oil. Only a small percentage of the chicks responded to 0.5 mg. The effect of 2 mg, likewise administered in 0.20 ml of cod liver oil, was found to last for more than 48 hours; but at the end of the third day, all the chicks showed an abnormal clotting time. The administration of 3 mg of the concentrate in 0.20 ml of cod liver oil kept the coagulation power of the blood normal in about 50 per cent. of the chicks for 72 hours; it was found that 3.8 mg of the concentrate dissolved in 0.20 ml of cod liver oil was necessary to keep the blood-clotting time of all the chicks normal for 72 hours.

Obviously the above observations can be employed as the basis for a quantitative biological assay of vitamin K. Such a method has been used successfully with several hundred chicks and will be reported in full in the near future. This method would seem to fulfill the requirements of standardization studies for which there is an actual need, as pointed out recently in a paper by Smith *et al.*[5] on the effect of bile and vitamin K on bleeding tendency and prothrombin deficiency.

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[2] Unpublished data from this laboratory.

[3] H. J. Almquist and E. L. R. Stokstad, *Jour. Nutrition*, 14: 235, 1937.

[4] Since this paper was written, it was found that the clotting power of the blood of the vitamin K-deficient chick may become normal within 2½ hours after the feeding of a relatively high amount of the vitamin K concentrate.

[5] H. P. Smith, E. D. Warner, K. M. Brinkhous and W. H. Seegers, *Jour. Exp. Med.*, 67: 911, 1938.

[7] C. Edmund and S. Clemmesen, "On Deficiency of A Vitamin and Visual Dysaptation," Copenhagen, 1936, 92 pp.; C. Fridericksen and C. Edmund, *Am. Jour. Diseases of Children*, 53: 89, 1938.

[8] G. Wald, *Nature*, 140: 545, 1937; A. M. Chase, SCIENCE, 87: 238, 1938.

[1] H. J. Almquist and E. L. R. Stokstad, *Jour. Nutrition*, 12: 329, 1936.