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Comparison of the catalase content of the tissues of the mother and of the offspring.

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Hasselbalch[1] found that oxidation or metabolism is very low in the infant during the first month of life, and Magnus-Levy and Falk[2] that it is high during childhood. As a result of the work of these three observers and of Bailey and Murlin[3], Murlin and Hoobler[4], Howland[5], Benedict and Talbot[6], Benedict, Emmes, Roth and Smith[7], Palmer, Means, and Gamble[8], and others, it is now considered that oxidation or metabolism is low during the first month of life, high during childhood, and low after the onset of old age. Warburg[9] found that during the process of fertilization, oxidation was greatly increased in the sea-urchin egg. It is also known that oxidation is greatly increased in the greening of tubers and the germinating of grain. The present work is an attempt to find an explanation for the variation in the intensity of oxidation under the conditions named.

Since we[10] had found that whatever increased oxidation in the body, the ingestion of food, for example, produded an increase in catalase, an enzyme possessing the property of liberating oxygen from hydrogen peroxide, by stimulating the alimentary glands, particularly the liver, to an increased output of this enzyme, and that whatever decreased oxidation, narcotics for example, diminished catalase by decreasing its output from the liver and by direct destruction, we naturally turned to catalase for an expla-

[1] Hasselbach, *Bibliotek for laeger*, Copenhagen, 1904, 8, 219.

[2] Magnus-Levy and Falk, *Arch. f. Anat. u. Physiol.*, 1899, Suppl. 315.

[3] Bailey and Murlin, *Am. Jour. Obst.*, 1915, lxxi, 1.

[4] Murlin and Hoobler, *Am. Jour. Dis. Child.*, 1915, ix, 81.

[5] Howland, *Ztschr. f. physiol. Chem.*, 1911, lxxiv, 1.

[6] Benedict and Talbot, Carnegie Institution of Washington, Pub. 201, 1914. *Am. Jour. Dis. Child.*, 1914, viii, 1.

[7] Benedict, Emmes, Roth and Smith, *Jour. Biol. Chem.*, 1914, xviii, 139.

[8] Palmer, Means and Gamble, *Jour. Biol. Chem.*, 1914, xix, 239.

[9] O. Warburg, *Zeitschr. f. physiol. Chem.*, 1908. lvii, 6,

[10] Burge, *Am. Jour. Physiol.*, 1918; xlv, 4, 1918; xlvii, 1, 1918. xlvii, 3,

nation of the increase or decrease in oxidation under the conditions enumerated.

On examination of the literature, it was found that Winternitz [11] had already shown that the unfertilized hen's egg showed no catalytic activity even after prolonged incubation, whereas the incubated fertilized egg rapidly acquired the power of decomposing hydrogen peroxide. We repeated and confirmed these observations of Winternitz. Doubtless if Winternitz had determined the intensity of oxidation in the fertilized hen's egg, he would have found that this increased parallel with the increase he observed in catalase, and if Warburg had determined the catalase content of the fertilized sea-urchin egg, he would have found this enzyme increased parallel with the increase he observed in oxidation. J. Loeb [12] attributes the development of the fertilized sea-urchin egg to the increase in oxidation, and the increase in oxidation to a change in the cortex of the egg which makes the entrance of oxygen, and hence oxidation possible, while R. Lillie [13] holds that the cortical layer of the unfertilized egg prevents the diffusion of CO_2 from the egg and this CO_2 prevents oxidation, and hence development. A more plausible explanation for the increased oxidation or metabolism in the fertilized egg, and hence for the development of the egg, would seem to be that the spermatazoön furnishes a substance which stimulates the egg to an increased formation of catalase. Further evidence in support of this view is afforded by the fact that the very same chemicals (amines, alkalies, acetates, butyric acid, etc.) which Loeb found would bring about increased oxidation and artificial parthenogenetic development of the egg, we found when introduced into the alimentary tract of animals, stimulated the alimentary glands, particularly the liver, to an increased output of catalase with resulting increase in oxidation.

Battelli and Stern [14] found that the catalase content of most of the tissues and particularly of the liver of newly born pigs is lower than the corresponding tissues of the mother, but that the

[11] Winternitz and Rogers, *Jour. Exper. Med.*, 1910, xii, 12.

[12] Loeb, Artificial Parthenogenesis and Fertilization. University of Chicago Press, 1913.

[13] Lillie, *Am. Jour. Physiol.*, 1910, xxvii, 289.

[14] Battelli and Stern, *Arch. di Fisiol.*, 1905, ii, 471.

catalase activity rapidly increased until at the end of the seventh or eighth day it was as high as that of the adult. We repeated and confirmed these observations using the dog and newly-born puppies. We also determined the catalase content of the tissues of puppies that were about ten weeks old and found that the tissues generally were richer in catalase than those of the mother. The catalytic activity of the liver, for example, of the ten week old puppies was about thirty per cent. greater than that of the liver of the mother. The catalase was determined by adding one gram of the hashed tissue to hydrogen peroxide and the amount of oxygen liberated in ten minutes was taken as a measure of the amount of catalase.

Appleman[15] found that there was an increase in catalase parallel with the increase in oxidation in the greening of potato tubers, but that the oxidase activity was not increased and, in fact, was slightly decreased. He also found that the exposure of potatoes to ethyl bromide gas increased the catalase of the potato parallel with the increase in oxidation, while it had no effect on the oxidases.

The low metabolism or oxidation in the newly-born is attributed to the low catalase content of the tissues, due undoubtedly to the small ouput of this enzyme from the liver, while the high metabolism in youth is attributed to the richness of the tissues in catalase brought about by a large output of this enzyme from the liver. Likewise, the increase in oxidation or metabolism in the sprouting of grain or of potatoes is attributed to an increase in catalase. The increase in oxidation or metabolism and hence the development of the fertilized egg is attributed to the increase in catalase brought about by the stimulation of the egg by the spermatazoön to an acceleration in the formation of this enzyme.

[15] Appleman, The Maryland Agricultural Experiment Station, 1915, Bull. 191.