

This observation shows that alkali allows or accelerates the development of the egg through the neutralization of an acid. It is possible that we are dealing here with one of the cases which conform with Stieglitz's theory of catalysis by salt formation.

75 (485)

**How can the process underlying membrane formation cause the development of the egg?**

By **JACQUES LOEB.**

In a series of previous papers it was shown that the process underlying the formation of the fertilization membrane is the essential act in the causation of development. It was further shown that this process is essentially a cytolysis or liquefaction of the superficial (cortical) layer of the cytoplasm of the egg. The question arose, how can this cytolysis or liquefaction cause the egg to develop. It seemed natural to think first of the possibility that the superficial cytolysis rendered the egg more permeable for substances required for its development.

The possibility that fertilization might increase the permeability of the egg had been considered by me in 1906 (*Biochem. Zeit.*, 1906, ii, 87). I had found that a pure solution of sodium chloride is practically harmless for the unfertilized, but very toxic for the fertilized egg. Since lack of oxygen is likewise harmless for the unfertilized and very harmful for the fertilized egg, I was inclined to ascribe the difference in the toxic effect of sodium chloride to a difference in the velocity of chemical reactions and not to a difference in the permeability of the fertilized and unfertilized egg. I have recently resumed the investigation of this question with regard to the action of salts, alkalis and acids.

(a) *The action of salts.* — As stated, a pure solution of sodium chloride kills the fertilized egg much more rapidly than the unfertilized egg. In the preceding notice we have stated the concentration of hydroxylions below which the egg of *Purpuratus* can no longer develop. I find that below this limit a pure sodium chloride solution is much less toxic for the fertilized egg than above that limit. These experiments confirm the view that the difference in the toxic effects of a pure sodium chloride solution on the fertilized and unfertilized egg is due to a difference in the

velocity of chemical reactions and not to a difference in permeability.

(*b*) *The action of alkali.*—Sodium hydroxide injures or destroys the fertilized egg much more rapidly than the unfertilized egg. The experiments with neutral red mentioned in the previous paper indicate that this base diffuses equally well into the fertilized and the unfertilized egg but that in the former it enters into chemical combination, while in the latter it remains in solution. It can be shown that the toxic action of a comparatively high concentration of sodium hydroxide (e. g. N/500) upon the unfertilized egg can be enormously reduced through the addition of a trace of potassium cyanide, while in the fertilized egg the protective effect of potassium cyanide or lack of oxygen is equally noticeable, but for weaker concentrations of sodium hydroxide.

(*c*) *The action of acids.*—It was found that unfertilized eggs are killed by acids as rapidly as fertilized eggs.

All my attempts to show that the process of membrane formation causes the development of the egg by increasing its permeability have thus far met with negative results.

It is, however, possible to account in another way for the fact that the cytolysis of the cortical layer of the cytoplasm starts the development of the egg. In the process of cytolysis certain substances which were solid are liquefied and enabled to diffuse into the egg. If it could be shown that these substances were of such a nature as to start or accelerate the chemical processes underlying development the connection between membrane formation and causation of development would become intelligible.