that the radius of the electron is related to the Compton wave-length of the proton as 3 to $\sqrt{2}$. This may be interpreted as indicating that in the state of equilibrium of the universe one third of its primordial particles are protons, one third electrons and one third neutrons.

THE DEPARTMENT OF PHYSICS
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SPECIAL ARTICLES

IMMUNIZATION AGAINST EQUINE ENCEPHALOMYELITIS WITH CHICK EMBRYO VACCINES[1]

EQUINE encephalomyelitis is a virus disease which, during the past few years, has become increasingly prevalent in many parts of the United States. Fortunately, vaccines capable of producing immunity in susceptible animals can be prepared by formalinizing brain tissue from animals dying of the disease.[2,3] The horse brain now used for large-scale vaccination constitutes a relatively poor and inconstant source of virus. There is much evidence that the immunizing capacity of a vaccine of this sort is proportional to the amount of virus in the tissues before treatment with formalin. We have accordingly sought to produce a better vaccine by utilizing the exceptionally infectious tissues of chick embryos[4] diseased with the virus.

The high virus content of embryos has been emphasized by the fact that it has proved possible to isolate[5] from them, but from no other tissues, a homogeneous substance which seems to be the infectious agent. We have already prepared formalinized extracts of such tissues and have demonstrated that the immunizing principle they contain can be concentrated by ultracentrifugation.[6] In further experiments we have now studied the immunizing capacity of the formalinized embryonic tissues themselves and have compared it with that of the usual vaccines made from horse brain.

The viruses of both the Eastern and Western strains of equine encephalomyelitis grow equally well in chick embryos. The tissues of embryos diseased with the Eastern strain virus regularly attain a titre of 3×10^9 and under proper conditions 3×10^{10} mouse infective units per gram. The titre of the Western strain chick virus routinely lies between 3×10^8 and 3×10^9 m.i.u. per gram. The virus concentration in these tissues is 1,000 to 10,000 times greater than in the most infectious horse brain we have examined and the chick vaccine has proved to be correspondingly more effective as an immunizing agent.

Chick vaccine against the Eastern strain of equine encephalomyelitis has been tested by injecting guinea pigs with two doses at an interval of seven days. Two weeks after the second injection they have received an intracerebral[7] inoculation of 500 minimal lethal doses of virus-diseased horse brain. Of thirty animals vaccinated with eight different batches of vaccine every one was solidly immune and survived the test inoculation of virus with no evidence of disease. All control animals succumbed promptly.

Western strain chick vaccine is equally effective in protecting guinea pigs. One group of experiments utilizing 60 animals has demonstrated its superior immunizing capacity compared with that of a corresponding horse brain vaccine. The chick vaccine protected every tested guinea pig against 1,000 m.l.d. of virus, whereas no animal receiving the horse brain vaccine survived a test injection of 100 m.l.d. In preliminary experiments it has also protected every vaccinated horse against the intracerebral injection of enough virus to kill all the control animals.

In these experiments the vaccine consisted of a 10 per cent. diseased tissue suspension containing 0.4 per cent. formalin. A 1 per cent. chick vaccine has protected about 60 per cent. of the vaccinated animals; more dilute vaccines have proved worthless.

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PROTOPLASMIC STREAMING, ELECTRIC POTENTIALS AND GROWTH IN COLEOPTILES OF TRITICUM AND AVENA

THE effect of electric potentials on protoplasmic streaming in coleoptiles of Triticum and Avena in relation to transport and growth has been studied. Cholodny *et al.*[1] have reported that applied currents mainly decrease growth; Lund *et al.*[2] relate polarity of the plant with observed electric polarity, while on the other hand Clark *et al.*[3] report that the electric

[1] The part of this work carried out at Duke University has been made possible through the interest and aid of Lederle Laboratories, Pearl River, N. Y.

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[7] Operations on animals were made under full ether anesthesia.

[1] N. Cholodny and E. Sankewitsch, *Plant Physiol.*, 12: 385, 1937.

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[3] W. G. Clark, *Plant Physiol.*, 12: 409, 1937; *ibid.*, 12: 737, 1937.