

subsequent paper. Hypertrophy of the kidneys existed without hypertrophy of the heart. The ratio of the weight of the heart as well as of the liver to the body weight was about the same in the animals fed the high protein diets as in the control animals. The ratio of the weight of the kidneys to the body weight in the animals on the high protein diets was, on the average, almost double that of the control animals. The hypertrophy occurred whether the protein used was of animal or vegetable origin or was rich or poor in phosphorus.

The animals on such diets were poorly or, at best, only moderately well nourished. The subcutaneous fat was scant and the skin adherent. There was some fat in the abdominal cavity and in certain animals it was fairly plentiful, but in none was it so abundant as in the control animals. In a considerable proportion of the animals the lungs showed the infection so commonly seen in the domestic rat. The thymus was invariably atrophied. The heart was normal. The spleen varied greatly in size. In some rats it was large, in others normal, and in others atrophic. The liver presented no gross abnormalities. The testes in some of the animals were normal in size; in others they were exceedingly atrophic.

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A contribution to the bio-physics of intestinal absorption.

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The following experiments were suggested by purely bio-physical considerations concerning absorption from the intestines and it was deemed desirable to report the same in this preliminary communication.

On purely physical-chemical grounds it can be shown that the absorption of a chemical in solution which flows through a membranous tube will depend on the speed of flow of the solution through the lumen of the tube. The authors attempted to

test this postulate on the living intestine in the following manner. Loops of intestines were tied off in dogs, cats and rabbits under anesthesia, and large inflow and outflow cannulas were attached to the two ends of the same respectively. A solution of the drug was perfused through the loop under proper precautions from above downwards, maintaining the temperature of the animal constant and a record was made of the blood pressure and respiratory effects. The drugs employed in these experiments were solutions of potassium cyanide and the powerful alkaloid, aconitin. These solutions were perfused at different rates as indicated by the outflow per minute. It was found that when the solution was perfused with slow speed the absorption was much greater than when the rate of flow was more rapid. The drugs may be perfused so rapidly that very little or no absorption of the poisons takes place at all. As illustrations of the above may be given experiments performed on two cats on December 21st, 1921.

Each animal was anesthetized with ether and in each after laparotomy a loop of intestine 30 cm. long was tied off. Through one of these a solution of potassium cyanide 0.5 per cent. was perfused, at the rate of 100 c.c. per minute. In the other cat a solution of the drug in the same concentration was perfused at the rate of 500 c.c. per minute. It was found that the first signs of poisoning as indicated by the respiration and blood pressure curves in the first cat came on much earlier than in the second cat and death occurred in the first experiment in less than one-half of the time after which it occurred in the second experiment. These results could be only interpreted on the assumption that absorption took place much more rapidly in the first cat than in the second. In another experiment, a dog was used and a loop of intestines of the animal was perfused with potassium cyanide, 1 per cent. solution. When the rate of perfusions was 200 c.c. per minute distinct signs of absorption were noticed as indicated by the respiration and circulation. When the rate of perfusion was increased to 700 c.c. per minute these signs disappeared and apparently very little absorption took place. Similar experiments were made in dogs and cats with preparations of potassium cyanide and also of aconitin. The results of these experiments indicated that the absorption was much more rapid when the rate of flow through the intestines was slow.

In another series of experiments, the authors put to test a different idea. It was thought interesting to determine in which way and to what extent intestinal peristalsis would influence the absorption of drugs from closed loops of intestine. To determine this point, experiments were made with the dye, phenolsulphonphthalein. A loop of intestine was tied off in a cat under anesthesia and 1 c.c. of phenolsulphonphthalein diluted in 10 c.c. of water was injected into the same. At the end of one hour the animal was killed, the intestinal loop was excised and the dye remaining therein was carefully rinsed out with alkaline solution and the amount of drug quantitatively determined by colorimetric methods. Another cat was treated in the same way. An intestinal loop of the same length was made, the same amount of dye and water was injected, but in addition to this the animal was given a hypodermic injection of a small dose of pilocarpin in order to stimulate intestinal peristalsis. At the end of one hour the amount of dye in the intestines and hence, the amount of dye absorbed was determined as above. In a third cat a similar experiment was performed but in this cat intestinal peristalsis was inhibited by an injection of atropin and after one hour, the amount of absorption was again colorimetrically determined. It was found that after mild stimulation of intestinal peristalsis, as for instance with small doses of pilocarpin (0.2 mgm. per kilo) absorption also was greater than in a normal cat. On the other hand, after inhibiting the peristalsis with atropin or with other drugs, absorption was not as great, as illustrated by the following experiments.

Cat A. Loop of 30 cm. injected, 1 c.c. of phenolsulphonphthalein in 10 c.c. water. Absorption at the end of one hour, 55 to 60 per cent.

Cat B. Intestinal loop of the same length and the same amount of phenolsulphonphthalein was injected. The cat was given a hypodermic injection of pilocarpin hydrochloride (0.2 mgm. per kilo). At the end of one hour the amount of dye absorbed was 80 to 90 per cent.

Cat C. Similar loop of intestines was injected with the same amount of dye. Atropin sulphate, 1 mgm., was given to this cat. Amount of dye absorbed at the end of one hour was 40 per cent.

In another series of experiments the intestines were paralyzed by an intraperitoneal injection of a 1 per cent. solution of benzyl

alcohol which inhibited peristalsis by direct action on the muscle cell. The same results as with atropin were obtained in this cat. In the case of pilocarpin, the increased absorption is to be explained by more violent peristaltic movement of the intestinal muscles which knead the intestinal contents more vigorously and in that way promote more rapid absorption of the dissolved substances. When a large dose of pilocarpin was injected, for example, 1mgm. or more per kilo, the intestines went into a tonic spasm and this clamping down of the intestinal muscles decreased absorption to below the normal. Further studies are in progress, especially in regard to the relation of blood circulation to absorption from intestines. This communication is in the nature of a preliminary report and it is hoped that further work may be continued on the subject.

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Effects of repeated transplantation of whole suprarenals into young doves.

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In much of the literature on the suprarenal glands one or another relation of these organs to sex and to reproduction is more or less clearly indicated. In a study of these relationships only slight success has been obtained from efforts to transplant suprarenal tissue.^{1,2} The present study was chiefly an attempt to obtain functional grafts of whole suprarenals in young doves and pigeons; or, if persistent transplants were not obtained, to repeat the transplantations at intervals during growth so that some of this tissue would be either functioning or in course of resorption during a considerable part of the period of immaturity; and then to examine several aspects of sex and of reproduction in the treated animals.

¹ Poll H., *Arch. f. mikr. Andt.*, 1899, liv, 440.

² Schmeiden, F., *Zeitschr. f. Chirurgie*, 1903, lxx, 453.