tainer be coated with paraffin so that the blood does not come in contact with the bare glass, clotting may be delayed for hours, or completely inhibited.

Briggs has shown in the preceding communication that a quartz diaphragm may be coated with protein so as to acquire the properties of a pure protein diaphragm. Undoubtedly this is due to the phenomenon of adsorption, possibly in accordance with the Gibbs principle that substances which decrease surface or interfacial tension tend to be adsorbed.

It occurred to us that possibly blood-clotting was dependent upon the adsorption of some constituent from the serum onto a surface, thereby increasing the effective concentration of this constituent and initiating the clotting phenomenon.

Streaming potential measurements showed that a bare glass capillary had a negative ζ-potential of approximately 30 millivolts,* whereas the same capillary coated with a thin layer of paraffin had essentially a zero ζ-potential against water. The high ζ-potential would favor electrostatic adsorption of positively charged colloids at the interface of glass-blood serum, and there would be no such tendency for a paraffin-blood serum interface. We accordingly postulate that the initial step in blood-clotting involves a surface concentration of some positively charged constituent, the concentration being brought about by selective adsorption.

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Experimental Production of Auricular Fibrillation by Several Stimuli Applied to the Auricle.

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Auricular fibrillation has hitherto been produced experimentally only by faradization of the auricle, and under these conditions the period of fibrillation rarely outlasts the period of stimulation. Moreover, though it is usually possible to cause spontaneous auricular fibrillation in the dog to cease abruptly after the injection of quini-

* The actual streaming potential which was measured between the 2 ends of the glass capillary was in excess of 4.5 volts at 30 cm. Hg hydrostatic pressure. With the same tube coated on the inside with a thin layer of paraffin, the streaming potential was essentially zero.

dine it is, as Alfred Cohn has reported,[1] only rarely possible to stop the fibrillation during faradization of the auricle. This practically prevents a satisfactory experimental study of the drugs that might be used to influence auricular fibrillation.

In this investigation we have produced auricular fibrillation in dogs by throwing into the auricle a cycle of 3 independent make and break induction shocks, about one-eighth of a second apart, each shock being applied to a different part of the auricle. The fibrillary contractions were easily visible in the wall of the auricle and in the electrocardiogram, and were accompanied by the usual absolute arrhythmia in the carotid pulse tracing recorded with a membrane manometer.

In these experiments we used the make and break secondary shocks from 3 independent Harvard induction coils, the secondary circuits of which led to a cylindrical electrode containing 4 insulated wires whose bare ends were about 2 mm. apart. One of these wires was connected with all 3 induction coils in order to complete the 3 circuits. The poles of the 3 primary circuits were connected with a dry cell and then with the base of a Harvard kymograph, the drum of which was covered with a piece of glazed paper bearing 3 perforations made in an oblique descending line, each perforation about 5 mm. in front and above the next one. As the drum was rotated rapidly, a contact was made whenever one of these perforations moved past a spring brass wire set upon a ring stand (from which it was insulated) and this brass wire passed to the second electrode in the primary circuit of one of the induction coils. As the drum rotated once in 6 seconds, this gave a cycle of 3 independent stimuli to different parts of the auricle with an interval of about one-eighth of a second between them. This is about equal to the A-V conduction time.

A single cycle of these stimuli sufficed to set up a "circus movement" in the auricle and in every experiment but one resulted in the development of fibrillation. In almost every experiment we were able to obtain periods of fibrillation which greatly outlasted the periods of stimulation. The fibrillation sometimes lasted from one-half to 2 hours, and we were able to obtain lasting fibrillation by this method in a number of dogs when fibrillation produced by faradization ceased within a few seconds after cessation of the stimulation.

Fibrillation produced in this way was cut short almost immediately by the injection of a few cubic centimeters of 1% quinidine

[1] Cohn, A. E., and Levy, R., PROC. SOC. EXP. BIOL. AND MED., 1921, xviii, 283; *J. Am. Med. Assn.*, 1921, lxxvi, 1605.

sulphate solution. It is also significant that the only experiment in which we have failed to produce fibrillation was in a dog which showed spontaneous fibrillation when the chest wall was removed, and in which the fibrillation had been stopped by a large dose of quinidine before stimulation was attempted.

In our experiments, whenever the stimuli have been applied to rapidly beating hearts, either during stimulation of the accelerators, after atropinization, or after small doses of epinephrine, the resulting fibrillation has never lasted more than a few seconds, whereas we have usually obtained fibrillation lasting from half a minute to 2 hours when the stimuli have been applied to hearts whose vagi were being stimulated either electrically, with pilocarpine or with large doses of epinephrine.

Further studies upon the influence of these factors, as well as upon variations in acid-base equilibria, effects of ions, etc., are in progress.

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Effects of Epinephrine Injections upon Deep and Superficial Blood Vessels of Frog's Tongue.

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Investigations by Cannon and his collaborators[1, 2, 3, 4] have shown that while intravenous injections of epinephrine cause the whole limb to decrease in volume, an increase in volume may be recorded if the skin of the limb has been removed. In other words, epinephrine causes vasoconstriction in the vessels of the skin but not in those of the muscle. We have observed a similar phenomenon in the arterioles of the frog's tongue. If the frog's tongue is observed under the microscope, the superficial capillaries supplying the mucous membrane can be seen as loops closely resembling the familiar capillary loops in the human skin, while the deeper vessels supplying the muscles of the tongue run a much less tortuous course. After the injection of 1.5 cc. of 1:100,000 epinephrine solution into the dorsal or ventral lymph sac, most of the super-

[1] Cannon, W. B., and Lyman, H., *Am. J. Physiol.*, 1913, xxxi, 376.

[2] Gruber, C. M., *Am. J. Physiol.*, 1918, xlv, 302.

[3] Hartman, F. A., and Kilborn, L. G., *Am. J. Physiol.*, 1918, xlv, 111.

[4] Hartman, F. A., Kilborn, L. G., and Fraser, L., *Am. J. Physiol.*, 1918, xlvi, 168.