findings of Okey and Boyden[3] concerning the fluctuations in the blood cholesterin in relation to the menstrual cycle, and also agrees completely with the much earlier findings in the extensive study of Goñalons.[4] It is well known now that ultra violet irradiations produce important changes in the physical and chemical properties of cholestrin, and as pointed out by Beumer,[5] one of the products formed as a result of such irradiation appears to be a substance exhibiting properties attributed by Lifschütz to oxycholestrin.[6] All these facts are of great interest when considered in connection with the effect of ultra violet on menstrual serum here described. The present findings corroborate the original views of the author, that menotoxin is chemically related to oxycholestrin. The table gives illustrations of some of the results obtained.

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[4] Goñalons, G. P., *La Semena Medica*, 1916, No. 51.
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Neural and Chemical Control of Ciliated Epithelium.

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(Introduced by V. E. Levine.)

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Practically all workers upon ciliated epithelium have denied that it possesses a nervous control. It is generally held that this type of contractile tissue possesses the property of automaticity, like the heart, digestive organs, urinary bladder, etc., but that, unlike these viscera, it is independent of neural domination. Textbooks of physiology usually omit the question of control in discussing this tissue, and sometimes ignore the subject of ciliated epithelium altogether. Parker and others[1, 2] hold that nervous control of ciliated epithelium is extremely improbable. The histological features of this type of epithelium have been intimately worked out by histologists. A beautiful mechanism, apparently for inter-epithelium coordination, has been described by Grave and Schmidt.[3] Agersborg[4] has recently noted nerve fibers extendnig from the pedal ganglion (of Melibe)

to the base of the ciliated columnar epithelium of the ectoderm of the foot. Merton,[5] working on fresh water snail, has recently given evidence for nervous control of ciliated epithelium in this lower form. The weight of authority is, however, decidedly against the view that ciliated epithelium is controlled by means of regulatory nerves.

We have performed many experiments which we believe show conclusively that ciliated epithelium in the vertebrate is definitely under the control of the nervous system. We believe our experiments show just as conclusively that ciliary movement is also subject to chemical control.

For most of this work, we studied the action of ciliated epithelium in the mouth and pharynx of the frog. Our method was as follows: The time in seconds in which this epithelium propelled a particle of cellulose across the field of a binocular microscope was established as a speed norm. Then the rate of travel of the same particle across the same field was determined during and following the stimulation by various methods of the sympathetic and parasympathetic nerves supplying the pharynx.

Electrical stimulation was obtained by means of an inductorium attached to a six volt electric cell, the current used being of just such strength as to give a distinct sensation when applied to the tongue of one of us. The chemical stimuli consisted of sympathetic drugs, ephedrine sulphate and adrenalin, and the parasympathetic drug, pilocarpine.

We made many records of the rate at which the ciliated epithelium of the frog's mouth and pharynx propelled a cellulose particle across the field of the microscope, both before and after stimulation of the sympathetic cord in the region of the brachial plexus. In every case, upon stimulation of the sympathetic, the rate of propulsion was markedly accelerated, in comparison with the rate before stimulation. The resultant increase of speed was 100 to 172.7 per cent.

We obtained a similar speeding up of ciliary action after the injection of epinephrine and ephedrine. These compounds also usually caused the secretion of thick mucus in considerable amounts. The mucus, however, did not prevent the acceleration of speed of the cellulose particle across the microscopic field until a considerable amount of it was secreted.

It is clear from these experiments that ciliated epithelium is speeded up in its action by electrical stimulation of the sympathetic nerves. It is also accelerated by sympatho-mimetic chemical com-

pounds, as adrenalin and ephedrine. Gray[6] showed that the reaction of ciliated epithelial cells to different ions was similar to that of cardiac muscle tissue.

The question arose: Is ciliated epithelium also under the control of the parasymapthetic nervous system? To this question our experiments also give a positive answer.

The point of stimulation of the parasympathetic was the seventh and the ninth cranial nerves as these issue from the *medulla oblongata.* Before stimulation of these nerves the *medulla oblongata* was completely isolated from the rest of the neuraxis by total transverse sections at the cephalic end of the spinal cord and at the cadual end of the midbrain.

Upon establishing again a speed norm, we found in every case upon stimulating the nerves containing parasympathetic fibers to the mouth and pharynx that the rate of ciliary movement was slowed up. The decrease in movement ranged from 78.9 to 114.8 per cent.

After injection of pilocarpine, the rate of speed of the ciliated epithelium was markedly slowed. The rate of slowing ranged from 81.8 to 117.7 per cent.

Sunlight or heat accelerated ciliary movement markedly, and cold decreased it.

Upon examining the action of ciliated epithelium directly through the microscope, we could observe clearly the markedly accelerating and retarding effects of stimulation of the sympathetic and parasympathetic nerves when stimulated electrically and indirectly by the various drugs mentioned above.

Conclusion. The rate of action of ciliated epithelium of the mouth and pharynx of the vertebrate (frog) is increased as a result of electrical stimulation of its sympathetic nerve supply, and decreased as a result of electrical stimulation of its parasympathetic nerve supply.

The rate of ciliary action is also markedly increased by the injection of sympatho-mimetic chemical substances, like epinephrine and ephedrine, and markedly delayed by the injection of the parasympatho-mimetic drug pilocarpine.

This is a preliminary report.

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