averaged 5.3, 8.6, 5.8, and 6.1 mg. per day for 14 rats on the first day and 11 animals on the other days which corresponds with an excretion of 0.14, 0.24, 0.16, and 0.17 gm. per sq. meter of body surface respectively. The females developed an appreciable ketonuria in distinction to the almost blank values on the males. Thus, the acetone body excretion in the urine gave a mean of 21.3, 39.6, 39.2, and 37.4 mg. of acetone of 14 rats on the first day and 11 on each of 3 following days. The values calculated on the basis of grams per square meter of body surface per day were 0.77, 1.39, 1.39, and 1.32 gm. respectively. A normal response to diacetic acid administration was demonstrated on a control day. The experiments show the greater susceptibility of the female rat to alkalosis than the male.

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Effects of Short Wave Electric Fields on Cataphoretic Velocities of Streptococci.

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A type of radiotherm developed in the Research Laboratories of the General Electric Company was used for the production of the high frequency fields. The oscillator delivered approximately 0.1 ampere per square inch of plate surface at a frequency of 27.3 million cycles (wavelength 11 meters). Cataphoretic measurements were made at level 0.211 D, where D is the total depth of the flat cataphoretic cell in the Mudd assembly of the Northrup-Kunitz apparatus. Measurements during a long series of experiments indicated a mean potential gradient (v/1) of 7.0 ± 0.4 volts per cm. for the field strength, or driving force, in the center of the cataphoretic cell. The mobility, *u*, is calculated from the relationship:

$$u = \frac{d}{t_c \times (v/1)} = \frac{48.1}{t_c \times 7.0} = \frac{6.87}{t_c}$$

in which t_c is the "cataphoretic time," that is, the time required by the streptococcus to move over a distance "d" under the influence of the electric field of the cell. Throughout these experiments the room temperature was 25°C., with a variation of ±2°C.

The results of measurements of cataphoretic velocity are presented as distribution curves of cataphoretic time. As the cataphoretic time increases there is, therefore, a reduction in cataphoretic mobility and, presumably, in the net charge on the surface of the streptococcus. The distribution curves are based on the measurements of the velocities of 20 organisms of each suspension. In the distribution curves which are given in this paper, the total amount of energy of the high frequency field to which each of the cultures was exposed is proportional to the time stated in minutes above each distribution curve. The number of each suspension, indicating the order in which cataphoretic measurements were made on a series of tubes, is given in a circle to the left of each distribution curve. Subcultures are represented as tenths of the number; that is, 1.1 is the first subculture of streptococci in tube number 1, and so forth.

The details of the methods used in the isolation and preparation of cultures have been presented elsewhere.[1, 2]

When a tube containing 2 cc. of "dextrose-brain broth" was exposed to the high frequency field for a period of 5 minutes, the temperature of the contents of the tube rose 20°C. (from 25°C. to 45°C.). By intermittent application of the high frequency field it was possible to avoid lethal action and to bring the contents of all tubes in a given series to the same maximal temperature, which was approximate to, or slightly less than, the usual body temperature.

In Fig. 1 are shown the results of an experiment with samples of culture number 5829 (streptococcal strain isolated from the nasopharynx of a person in the early stages of acute epidemic poliomyelitis). The 12 sample tubes of this culture were exposed to the field for the respective total doses of 0 (2 controls), ½, 1, 1½, 2, 2½, 3, 3½, 4, 4½ and 5 minutes in cumulative doses of ½ minute each. A complete cycle of changes in cataphoretic distribution occurred during exposure of samples of the culture to the high frequency electric field for a period of 5 minutes. The 2 control cultures exhibited very similar types of distribution, consisting chiefly of streptococci at the time of 4 seconds. The sample of culture which had received 2½ minutes of treatment showed a marked distribution maximum at a cataphoretic time of 3 seconds, indicating a 30% increase in velocity as compared with the control cultures. The tubes at the 3 succeeding dosages showed progressive decre-

[1] Rosenow, E. C., and Jensen, L. B., PROC. SOC. EXP. BIOL. AND MED., 1930, **27**, 442.

[2] Rosenow, E. C., and Jensen, L. B., *J. Infect. Dis.*, 1933, **52**, 167.

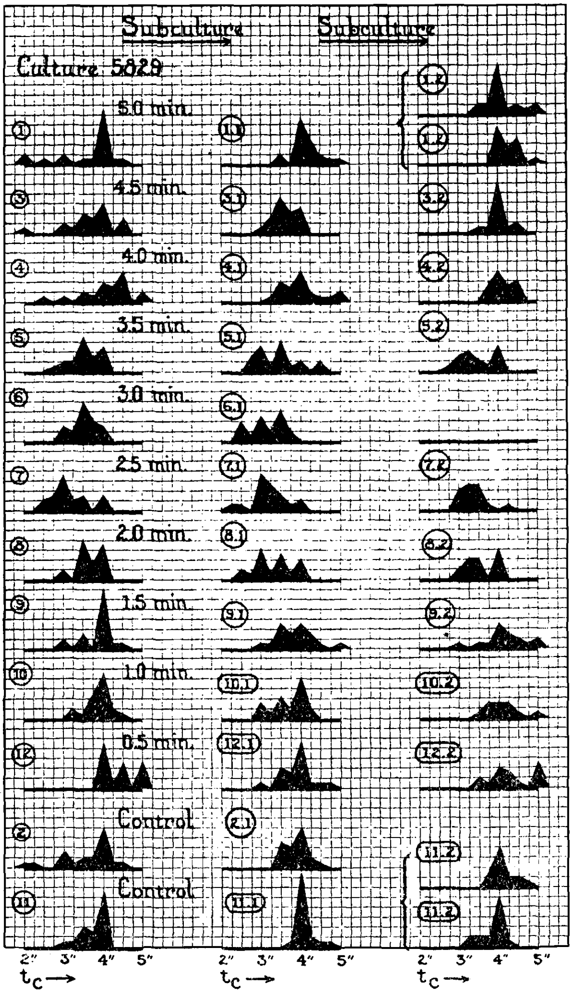

FIG. 1.

Distribution curves of cataphoretic time showing the cyclic shift in cataphoretic distribution produced by the application of a short electric wave field to samples of culture number 5829. The cycle of changes in distribution is maintained in two successive subcultures of each of the samples.

ments in cataphoretic velocity distribution. The tubes which had received exposures of 4½ and 5 minutes, respectively, possessed distribution curves nearly identical with those of the control tubes.

Each of the samples in this series underwent 2 successive subcultures. Although the distribution of each group of organisms in the subcultures is not always identical with that of the parent culture, nevertheless the cycle of changes produced by high frequency energy in the original series of samples is again evident in the series of subcultures.

In another series of experiments, 5 sample tubes of culture No. 5741 (strain isolated from the nasopharynx of a patient with severe ophthalmic herpes zoster) were exposed to the short electric wave field in cumulative intervals of one minute each for a total of 4 minutes. The control sample of culture showed a distribution with a marked maximum at a cataphoretic time of 4 seconds (1.7 $\frac{\mu/\text{sec.}}{\text{v/cm.}}$); and the tube treated for 2 minutes had a distribution in which the major portion of the organisms were found at a time of 3 seconds (2.25 $\frac{\mu/\text{sec.}}{\text{v/cm.}}$); on the other hand the tube exposed for 4 minutes showed a distribution practically identical with that of the control sample of the series.

The changes in cataphoretic distribution following exposure of a sample of culture to the short wave electric field do not appear to be explicable on any basis other than that of a direct effect of high frequency energy either on the streptococcus as a unit or on the surface regions of the organism. However, no information regarding the mechanism underlying the changes produced by high frequency fields is available. The voltage difference between the plates of the condenser, in the region in which the organisms were treated, amounts to about 2500 volts. This would give an electric field of approximately 0.05 volt per micron, alternating in direction about 30,000,000 times a second. The diameter of the streptococcus is approximately 1 micron. We do not know whether there are electric stresses set up in the orientated molecules of the surface of a particle which are sufficient to change the pattern of orientation. The quantum energy of this type of radiation would not appear to be of sufficient magnitude to produce effects such as those we have observed. *Conclusions.* 1. It is possible to produce changes in the cataphoretic distribution of streptococci by means of a high frequency electric field. 2. Successive increments of exposure to short wave electric energy produce cyclic or periodic changes in the cataphoretic distributions of the treated suspensions of streptococci. 3. The changes produced by high frequency fields in the cataphoretic distribution of streptococci are maintained in the subcultures of these organisms.