off from the surrounding green protoplasm. Finally the sharp contraction of the protoplasm at the tip of the cytopharynx may be observed, and the course of the newly formed food vacuole, with its pink and red contents, followed in its passage through the cytoplasm.

It should be pointed out that this color phenomenon is in no way due to changes in pH. It is not, therefore, an indicator effect such as was described by Nirenstein,[1] The effect has been demonstrated in several microscopic organisms by the use of acid fuchsin, phenosafranin or erythrosin. It appears to be a physical phenomenon, closely related to the existence of extremely thin films of dye solution. Further study of this effect is under way.

7589 C

Polarization Studies in Tissue Models.*

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It is known that the electric resistance of animal tissues, contrary to that of solutions, is not determined by the law of Ohm alone.[1] This has been explained as consequence of polarization caused by semipermeable cell membranes at cell interfaces. The degree of polarization and, therefore, of the permeability can be measured by the capacitance or inductance needed to obtain a sharp minimum on the Wheatstone bridge. As further manifestation of polarization, the resistance of tissues decreases with the increasing frequency of the alternating current. While other authors worked mostly with methods based on the first phenomena, we used the difference in conductivity at high and low frequencies as measure of membrane polarization and permeability. In order to elucidate to some degree the chemical and colloid-chemical conditions underlying the polarization and permeability phenomena, different artificial membranes with various constituents were used.

A Wheatstone bridge was employed. Alternating currents of

[1] Nirenstein, Edmund, *Z. f. wiss. Zool.*, 1925, **125**, 513.

* Aided by a grant from the Ella Sachs-Plotz Foundation.

[1] Gildemeister, M., *Handb. d. norm. und pathol. Physiol.*, 1928, **8**, 657.

various frequencies (560 to 6890 cycles) were provided by an oscillator built according to the description of Jones and Joseph,[2] in combination with an amplifier.† The difference between the conductance at highest and lowest frequency was expressed in percentage of the conductivity at low frequency. This value will be called Δ in this paper. In order to obtain a sharp minimum, variable capacities (up to 0.5 M. F.) were employed. The conductance vessel consisted of 3 glass cells, the outer cells contained electrodes of platinum wire gauze covered with black of platinum. Their surface was 3.8 $cm.^2$, the distance was 21 mm. Between the outer cells and the middle cell one or 2 membranes could be placed. The apparatus was filled with KCl solutions, whose concentration varied depending on the resistance of the membrane. (.01-1 n solutions). The method was first checked on frog's skins which gave a Δ of 23% (high frequency 6890 cycles, low frequency 560 cycles).

Results. When parchment, collodium, 30% gelatine membranes hardened in formaldehyde (Collander[3]), 30% gelatine membranes containing 2.5% pseudoglobulin were measured, Δ did not exceed 0.4%. Thus proteins alone seem to play no or only a minimal part in the mechanism of polarization observed in tissues.

The behavior of lipoid membranes (containing egg lecithin Merck, pure lecithin, or kephalin from human brains) depends on their preparation. The first group of these membranes was prepared from collodium-ether solutions containing from .2-5% of the respective lipoids in molecular or lowly polymerized dispersion. These membranes showed definite polarization phenomena. (See Table I.)

In the preparation of the second group of the lipoid membranes, gelatine, up to a concentration of 30%, was added to watery colloid solutions of lecithin or kephalin. While the lecithin-gelatin membranes were translucent, the kephalin-gelatin membranes were

TABLE I.

Lecithin in %	Frequency of the alternating current low	high	Δ for 1 membrane	Δ for 2 membranes
.2	1115	4860	4.7%	
2.5	560	4860	9 %	40.6%
5	560	6890		71.2%
5	560	4860	15.7%	
5	560	6890	16.5%	

2 Jones, G., and Joseph, R. C., *J. Am. Chem. Soc.*, 1928, **50**, 1049.

† We wish to express our thanks to Dr. G. Henny for his help in building the oscillator.

3 Collander, R., *Protoplasma*, 1927, **3**, 213.

opaque. Nevertheless they gave the same results in the conductance measurements, both showing low values of Δ (maximum: .4%.)

These experiments show that polarization phenomena as observed in animal tissues can be imitated by lipoids. They show, furthermore, that the polarization, as measured by Δ, depends on the degree of dispersion of the lipoid in the membrane. Membranes containing the lipoid in fine dispersion show high degree of polarization (high value of Δ) as do animal tissues, while membranes with lipoids in coarse dispersion show no or only minimal polarization.

This conclusion is corroborated by microscopical studies of the lipoid membranes. The collodium-lecithin membranes are homogeneous, while the gelatin-lecithin membranes show doubly refracting lecithin lumps in irregular distribution.

The polarization of the lipoid membranes (as expressed by Δ) was increased when the membranes were placed in .05 n HCl for 24 hours. It was diminished or destroyed by analogous treatment with .05 n NaOH or 95% alcohol. The change in the alcohol was irreversible due to the extraction of lecithin. The polarization of lecithin membranes treated with alkali could be restored by subsequent exposure to acid (.05 n HCl).

These experiments on membranes were followed by similar studies on brain tissue. According to Nernst[4] and others, excitation is supposed to be due to a change of ion concentration on semipermeable membranes. Thus it seemed of interest to study agents that influence the convulsant reactivity in regard to their effect upon the polarization of brain tissue with this method. It was found on the cerebral hemispheres of cats and guinea pigs that Δ diminishes under the influence of agents that produce a swelling of the tissue (hypotonic salt solutions, alkali). These studies are being continued with special reference to convulsive reactions.

7590 P

Cause of Laxative Effect of Feeding Bran Pentosan and Cellulose to Man.

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Recent work suggests that the laxative effect of bran in animals and man is due to its fibre content. But in addition to fibre there

[4] Nernst, W., *Pflügers Arch. f. Physiol.*, 1908, **122**, 275.