cholesterol is fed, it has been found that approximately 1 mg. is needed to initiate healing.

Other experiments will be undertaken to ascertain the relationship of ergosterol to cholesterol and the extent of its distribution in the animal body. This is a complete report.

[1] Hess, A. F., and Windaus, A., PROC. SOC. EXP. BIOL. AND MED., 1926, xxiv, 171.

[2] Hess, A. F., and Windaus, A., PROC. SOC. EXP. BIOL. AND MED., 1927, xxiv, 369.

3417

Proteins and Non-protein Colloids as Bioelectric Models.

R. BEUTNER AND A. MENITOFF.

From the Department of Physiology and Pharmacology, School of Medicine, University of Louisville.

The following experiments were undertaken in order to test the rôle of colloids in the production of electric currents in tissues. Hober[1] and his collaborators, Matsuo,[2] Mond,[3] and Deutsch[4] have tested cell arrangements with various proteins as middle conductors, *e. g.*, 1/10 mol. solution of KCl gelatin, 1/10 mol. solution of LiCl + about 0.01 volt, and compared these with other arrangements in which various animal or vegetable tissue took the place of gelatin.

Generally an agreement has been found. It has not yet been shown, however, whether non-protein colloids like agar agar might not act in the same way as proteins. To ascertain this, analogous cells with agar agar, etc., were measured and compared with the protein cells. With protein cells the following electromotive forces have been observed, m/10 KCl being constantly on the one side of the proteins, 1/10 mol. solutions of various solutions on the other side.*

* The technique of these measurements is simple. The protein is poured into a glass tube, open at both ends, filling the entire lower half of the tube as a plug. The upper end of the plug is constantly in contact with m/10 KCl, and this again with a saturated KClHgCl electrode; the lower end of the plug is dipped successively into the various salt solutions, which in turn are in contact with the second electrode. A binant electrometer was used for measuring the electromotive forces in the present research, but a compensation apparatus with a galvanometer would do the same service. Control tests in which the lower end of the protein plug dips also into m/10 KCl are always necessary. This symmetrical arrangement should show no electromotive force, but it usually does, consequently this e. m. f. must be subtracted from all the value observed.

TABLE I.

Electromotive forces in milli volts with the following proteins as middle conductors.

Variable salt solution (against KCl)	Neutral gelatin tannate observed by			10% gelatin observed by Writers	Euglobulin (Mond)	Casein (Mond)
	Matsuo	Mond	Writers			
	millivolts	millivolts	millivolts	millivolts	millivolts	millivolts
NaCl	1	7	9	7	25	15
LiCl	4	12	15	12	27	21
$(C_3H_7)\ NH_3Cl$	4.5		19	9		
$(CH_3)\ NCl$	6		19	13		
K_2SO_4	—7	—16†	—15	—13	—28†	—22†
Na salicylate	2.5		—6	—10		

† These measurements of Mond are made with 1/10 NaCl against 1/10 Na_2SO_4. One can assume that this approximately equals the value of 1/10 KCl against 1/10 K_2SO_4.

This shows that the result of the measurements varies within wide limits. Even for the same protein (gelatin tannate) Matsuo and Mond, both working under Hober's direction, obtained quite different figures. The range of the electromotive forces observed for all the proteins cited, is given in the following table, and it is to be compared with the electromotive forces observed on agar agar, starch and kaoline.

TABLE II.

	Range of e.m.f. on various proteins	e. m. f. on agar agar	e. m. f. on starch paste	e. m. f. on kaoline
	millivolts	millivolts	millivolts	millivolts
For NaCl	1 to 25	7	8	7
For LiCl	4 to 27	10	18	11
For $(C_3Hg)\ NH_3Cl$	4 to 19	12	13	10
For $(CH_3)_4\ NCl$	6 to 19	13	13	10
For K_2So_4	—7 to —28	—15	—9	—19
For Na salicylate	2.5 to —10	—8	—7	—7

The evidence shows that the values observed on non-protein colloids lie well within the range of the protein electromotive force in every instance.

A similar coincidence was observed with various other electrolytes, particularly with methylenblue and other dyes. In all these cases, agar agar and the other non-protein colloids exhibited electromotive forces resembling closely those of protein cells.

Gelatin and agar agar exhibit different electromotive forces under certain circumstances, *viz.*, in regard to the effect of the concentration with addition of acid and alkali, as has recently been pointed out by Michaelis.[5] (This point will be taken up by a subsequent publication.) In this respect, however, gelatin is far from being a model to biological electromotive forces, as will be shown later.

Conclusion: As far as gelatin or other proteins may serve as a model for bioelectric currents, their action is identical with that of agar agar, starch paste or kaoline. This is a complete report.

---

[1] Hober, R., *Z. Physik. Chemic.*, 1924, cx, 142.

[2] Matsuo, T., *Pflüger's Archiv.*, 1923, cc, 132.

[3] Mond, R., *Pflüger's Archiv.*, 1924, cciii, 247. Also see Fujita, A., *Biochem. Z.*, 1925, clxii, 245.

[4] Deutsch, W., *Pflüger's Archiv.*, 1925, ccix, 675.

[5] Michaelis, L., *Naturwissen Schfaten*, 1925, xiv, 33. See also Fujita, A., *Biochem. Z.*, 1925, clxii, 245.

ADDENDUM.

"Measurements of Fatal Doses of Chloroform in the Brains of White Rats," Vol. XXIV, pp. 340-341. The heading of the second column should read "Chloroform in brain tissue, cm. per gm," instead of cc. per gm.