

Table 1. ESTIMATES OF TRYPTOPHAN AND 5-HYDROXYTRYPTAMINE ($\mu\text{GM./GM. TISSUE}$) IN DOG BRAIN

Part of brain	Tryptophan	5-Hydroxytryptamine
Cerebral hemispheres	0.1	0.01
Hypothalamus	5-40	0.40
Mid-brain	2-8	0.35
Cerebellum	1-4	0.02
Pons	1-20	0.05
Medulla	2-5	0.25
Spinal cord	0.2	0.02

cord showed only traces. The results for the dog are shown in Table 1 together with estimates of 5-hydroxytryptamine for the corresponding areas. Inspection of the figures shows that the tryptophan content of three areas—the hypothalamus, cerebellum and pons—was about 100 times that of 5-hydroxytryptamine whereas the ratio was only 3-10 for the other parts. A similar result has also been found for cat and rabbit brain. The reason why the hypothalamus, cerebellum and pons are relatively rich in tryptophan and poor in 5-hydroxytryptamine is not clear at present.

SHIRLEY A. P. PRICE
G. B. WEST

Department of Pharmacology,
School of Pharmacy,
29/39 Brunswick Square,
London, W.C.1.

Resting Potentials in Isolated Frog Sartorius Fibres at Low External Potassium Concentrations

IN earlier experiments referred to by Conway^{1,2}, it was shown that the resting potential (E) of isolated frog sartorius fibres corresponded to the theoretical values as determined by the relation:

$$E = \frac{RT}{F} \ln \frac{[K]_o}{[K]_i} = \frac{RT}{F} \ln \frac{[Cl]_i}{[Cl]_o} \quad (1)$$

provided the conditions were such that a 'balanced state' (state of zero net flux) existed for the sodium and potassium ions.

The validity of the Conway theory, from which such an equation may be derived, has been well tried and supported by Küsel and Netter³, by Mond⁴, Adrian⁵, Hodgkin⁶; Hodgkin and Horowitz⁷; also for mammalian skeletal muscle by Pillat, Kraupp, Giebisch and Stormann⁸.

Here various potential measurements using the micro-electrode technique⁹ were carried out¹⁰ with fibres of frog sartorius which had been immersed overnight at 0-3° C. in Ringer-Conway fluid with constant sodium concentration, and potassium values up to very high concentrations, as great as 200 mM¹¹.

A series of determinations was also carried out with the impermeant anion, acetate, replacing all the chloride in the external solution, potassium being substituted for sodium up to high levels, the solution being thus maintained isotonic.

In both these types of experiment the theoretical potential with respect to the potassium ion was obtained above external values greater than 10 mM. Below this level the potential tended to fall below the theoretical figure, corresponding with the observations of Adrian, and of Hodgkin and Horowitz.

Immediate determinations of the resting potential of isolated fibres using Ringer-Conway fluid with normal plasma potassium level of 2.5 mM gave a value of 92.5 ± 0.47 mV., the theoretical figure

being 100.1 mV. (the 'fibre water' potassium was 133 mM for the group of frogs used here). Adrian obtained similar results, the average fibre water potassium of his frogs being 139 mM.

The points on the curve of $\log [K]$ against E were shown by Hodgkin and Horowitz to be reasonably well fitted at the low potassium levels of 1-10 mM and 20° C. by the relation:

$$E = 58 \log \frac{[K]_o + 0.01 [Na]_o}{[K]_i + 0.01 [Na]_i} \quad (2)$$

Above an external concentration of potassium of 10 mM, this equation gives results practically identical with equation 1. The fall below the potential-levels from equation 1 at external values of potassium less than 10 mM could be assigned initially to either of two causes. First, to the existence of a sodium-potassium linked pump which would result in an equation of the second type given above.

It could also arise if a 'balanced state' with respect to sodium and potassium ions did not in fact exist for isolated sartorius fibres with the external potassium concentration less than 10 mM. These two views are also referred to by Hodgkin and Horowitz⁷, with the conclusion that their published observations are consistent with either of them.

To examine the question here the observation of Carey and Conway¹² was utilized that with plasma as the external medium the permeability of the fibres to sodium ions was retained closer to the normal.

Plasma was prepared by bleeding through an aortic cannula into a heparinized tube. The blood was centrifuged at once and the plasma analysed for its potassium content, suitably diluting or adding potassium chloride if necessary to give 2.5 mM.

Table 1

External fluid	External potassium concentration	Resting potential observed mV.	Resting potential theoretical mV.
Ringer-Conway	2.5	92.5 ± 0.47	100.1
Plasma	2.5	99.2 ± 0.7	100.1

Such results show that the hypothesis of a sodium-potassium linked pump is unnecessary with respect to the potential measurements for frog skeletal muscle, and is not the explanation of the fall from the theoretical potential values from equation 1, for isolated muscle at low external potassium-levels.

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RODERICK P. KERNAN

Department of Biochemistry and Pharmacology,
University College,
Dublin.

¹ Conway, E. J., "Metabolic Aspects of Transport Across Cell Membranes", ed. Q. R. Murphy (The University of Wisconsin Press, 1957).

² Conway, E. J., *Physiol. Rev.*, **37**, 84 (1957).

³ Küsel, H., and Netter, H., *Biochem. Z.*, **323**, 39 (1952).

⁴ Mond, R., *Pflügers Archiv. ges. Physiol.*, **261**, 243 (1955).

⁵ Adrian, R. A., *J. Physiol.*, **133**, 631 (1956).

⁶ Hodgkin, A. L., *Proc. Roy. Soc.*, **B**, **148**, 1 (1957).

⁷ Hodgkin, A. L., and Horowitz, P., *J. Physiol.*, **148**, 127 (1959).

⁸ Pillat, B., Kraupp, O., Giebisch, G., and Stormann, H., *Pflügers Arch. ges. Physiol.*, **266**, 459 (1957).

⁹ Graham, J., and Gerard, R. W., *J. Cell. Comp. Physiol.*, **29**, 99 (1946).

¹⁰ Kernan, R. P., and Conway, E. J., *Abstr. Int. Congr. Biochem.* (1955).

¹¹ Boyle, P. J., and Conway, E. J., *J. Physiol.*, **100**, 1 (1941).

¹² Carey, M. J., and Conway, E. J., *J. Physiol.*, **125**, 232 (1954).