INCREASE IN SODIUM CONCENTRATION OF THE ISOLATED FROG RETINA AFTER LIGHT STIMULATION

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Abstract

The activity of Na^{22} in the isolated, dark-adapted frog retina, after equilibration in frog Ringer's solution containing $Na^{22}Cl$, increased after light stimulation.

Although the generation of the ERG is an isolated retina requires sodium ions in the fluid surrounding the retina, there has been no evidence reported that sodium enters the retina as a result of light stimulation. Furukawa and Hanawa (1) reported that the substitution of isotonic glucose for sodium ions in the isolated toad retina completely abolished the retinal mass action potential, the electroretinogram (ERG), and also that lithium ions could not be substituted for the sodium ions. Hamasaki (2) reported that the ERG obtained from the isolated frog retina was reduced when the sodium was partially replaced by choline. The ERG reduction was linearly related to the logarithm of the sodium concentration in the surrounding fluid. This initial report is concerned with preliminary investigations that show the influx of radioactive sodium

22 ions into the retina following light stimulation.

Eyes were removed from curarized, dark-adapted frogs (Rana pipiens) and the retinas excised. The retinas were placed in a blackened beaker containing 25 cc. of frog Ringer's solution containing $Na^{22}Cl$ having activity of 8.0×10^3 disintegrations/min/ml. solution. After equilibration for approximately 23 hours in the Na^{22} Ringer's solution, the retinas were removed, transferred into plain frog Ringer's solution to remove any Na^{22} adhering to the surface of the retina, and then transferred to a counting tube. This counting tube was placed in a deep-well gamma counter, and the gamma radiation at 1.28 m.e.v. counted for 10 minutes.

The retina was then returned to the blackened beaker containing the Na^{22}. The light from a 300 watt photographic projector was focused on the retina for 10 minutes. The retina was again removed from the solution, containing the Na^{22}, dipped in frog Ringer's solution, transferred to a counting tube, and the gamma radiation counted. All manipulations were performed in dim red light.

Results from four retinas obtained from four frogs are shown in Table I. The difference in activity before and after exposure to light is given in the fourth column. The percent increased in Na^{22} activity in the retinas studied caused by the light exposure ranged from 20-45%, with a mean increase of 36%.

Table I

Retina	Activity of dark-adapted retinas. (average c.p.m.)	Activity of retina after light exposure (average c.p.m.)	Increase Inactivity (c.p.m.)	Per cent change in activity (c.p.m.)
A	345.4	453.0	+107.6	+44
B	410.2	472.6	+ 62.4	+20
C	331.7	411.2	+ 79.5	+34
D	432.7	584.0	+151.3	+45

Although, from the effects of sodium depletion on the ERG and from work on the squid photoreceptor, the increase in sodium concentration following light stimulation is not unexpected, these preliminary data are the first to actually demonstrate this increase in the retina. Data have been reported and models proposed relating the influx of sodium ions through the cell membrane of certain excitatory cells following stimulation of the cells to the action potential. These preliminary data suggest that similar models might be applied to the retinal action potential.

Additional work is in progress to determine the specificity for sodium, and which cells within the retina are responsible for the increase in sodium activity following light stimulation.

REFERENCES

1. Furukawa, T. and Hanawa, I., Effects of Some Common Cations on the Electroretinogram of the Toad, Japanese Journal of Physiology, 29: 189 (1955).

2. Hamasaki, D. I., Effect of Sodium Ion Concentration on the Electroretinogram of the Isolated Retina of the Frog, Journal of Physiology, 167: 156 (1963).