

## XXVIII. NEUROPHYSIOLOGY\*

### Academic and Research Staff

Prof. J. Y. Lettvin	Dr. E. R. Gruberg	Janet M. Faulkner
Prof. J. E. Brown	Dr. S. A. Raymond	Lynette Levy
Dr. S-H. Chung	B. Howland	Diane Major
Dr. E. Douglass		W. M. Saidel

### Graduate Students

R. J. Bobrow	J. E. Lisman	J. F. Nolte
R. E. Greenblatt	M. Lurie	M. Sporer
P. Haugen	K. J. Muller	R. S. Stephenson
C. D. Jones		Susan B. Udin

## RESEARCH OBJECTIVES AND SUMMARY OF RESEARCH

### 1. Project Plans

The specific research goals of our group for the coming year fall into two classes.

1. A new tool has suddenly come to light within the last month and has been kindly provided by Dr. Rita Levi-Montalcini, of Washington University. She has been able to grow single nerve cells from cockroach brain in a tissue culture at room temperature. These isolated cells put out axons that branch and rebranch. There are no glial cells, or satellite cells of any sort, in the neighborhood of axon or the branches. This lovely element allows us to examine in situ a good deal of our hypothesis, and a predoctoral student, Richard E. Greenblatt, is beginning on this project immediately. Otherwise, in what is probably our last year to be concerned with this problem, both Dr. Chung and Dr. Raymond, together with their students, are planning an effort to discover whether the code-handling hypothesis actively applies in live nerve tissues.

2. The other class of projects reaches widely over a variety of fields. Among these are: (a) Anatomically we seek to destroy the cells in a piece of cortex, or, alternatively and most importantly, in the lateral geniculate body leaving the fibers intact. We shall try to accomplish this by the local application of Actinomycin, which apparently has not been used, except grossly, in the nervous system. (b) We are re-examining the functional structure of receptive fields in the eye of the cat under the assumption that the description of the center that has been accepted thus far is incomplete. The factor that has not been included, we suspect, is sharpness of boundary in the center where this quality may not be important in the surround. (c) Dr. Edward R. Gruberg, who recently joined us, is re-investigating some of the problems in organizing and disorganizing of regrowing nerve tissue in amphibia, particularly with respect to the optic tectum. (d) We are still anxious to pursue the transmission of information between two stentors coupled by a protoplasmic bridge, as described in an earlier report. (e) Finally, we are producing a manual for inexpensive and reliable construction of electrical apparatus for workers in physics. Our aim is to provide an almost complete laboratory for less than \$100, independent of the always necessary oscilloscope.

J. Y. Lettvin

---

\*This work was supported principally by the National Institutes of Health (Grants 5 RO1 NB-07501-02, and 5 PO1 GM14940-03), by a grant from Bell Telephone Laboratories Incorporated, and by the National Eye Institute (Grants 9 RO1 EY00312-04 and 5 PO1 GM14940-03); and in part by the National Institutes of Health (Grant 5 TO1 GM-01555-03).

## 2. Project Plans

The main interest of our group continues to be the elucidation of the mechanism underlying the generation of the receptor potential in invertebrate photoreceptors. This work is proceeding along four main lines.

1. In collaboration with Dr. T. G. Smith, Dr. W. K. Stell, and Dr. G. C. Murray, of the National Institutes of Health, and Dr. J. A. Freeman of Wright-Patterson Air Force Base, we shall continue the study of the ventral eye photoreceptors in Limulus polyphemus. In those cells, we have proposed that the steady-state portion of the receptor potential is generated by a light-induced change in a current source that operates across the nonlinear impedance of the membrane. We have inferred that this current source is associated with an electrogenic "sodium-pump"; that is, it is dependent on the activity of a  $\text{Na}^+$ ,  $\text{K}^+$ -ATPase. Recently, we have found evidence that the transient (wave) component of the receptor potential may be generated by a conductance increase mechanism. The initiation of this conductance increase by light seems to depend, however, in a nontrivial way on the presence of a normally functioning sodium pump.

2. Since the Limulus ventral eye appears to generate the steady-state receptor potential by a mechanism quite different from that usually found underlying bioelectric phenomena, we are doing comparative studies on other invertebrate photoreceptors. Kenneth J. Muller is studying the reticular cells in crayfish eyes.<sup>1</sup> In these cells, the steady-state receptor potential is apparently generated by a conductance-charge mechanism.

Also, John E. Lisman is studying both the Limulus ventral eye and the eye of the barnacle, Balanus eburneus, using the voltage-clamp technique. This technique will provide information previously unavailable for the Limulus eye, as well as a comparison between the Limulus eye preparation and another eye which apparently operates the receptor potential via a conductance increase mechanism.

3. Jack F. Nolte continues the study of the median ocellus of Limulus; this eye has been shown to contain receptor cells sensitive to both visible and ultraviolet light. The spectral sensitivities of the receptor cells in this eye have been determined,<sup>2</sup> and also the density spectrum of the screening pigments in both lateral and median eyes of Limulus has been quantified.<sup>3</sup>

4. In collaboration with Professor Charles E. Holt III, of the Department of Biology, M. I. T., we shall continue the study of the ion fluxes, in the light and dark, from the photoreceptor cells in Limulus ventral eye, using radioactive tracers.<sup>4</sup> In particular, we have determined that light causes a rapid, large increase in the efflux of potassium ion. We are attempting to quantify the dependence of this phenomenon on light and membrane voltage.

J. E. Brown

## References

1. K. J. Muller and J. E. Brown, "Crayfish Reticular Cells: Mechanisms of Generating the Receptor Potential," Abstracts of the Third International Congress of the International Union for Pure and Applied Biophysics, M. I. T., Cambridge, Mass., August 29-September 3, 1969, p. 261.
2. J. F. Nolte and J. E. Brown, "The Spectral Sensitivities of Single Cells in the Median Ocellus of Limulus," *J. Gen. Physiol.* **54**, 636-649 (1969).
3. J. F. Nolte and J. E. Brown, "Spectral Sensitivity of Single Photoreceptors in the Lateral and Ventral Eyes of Limulus," (A) *Biol. Bull. Woods Hole Marine Biological Laboratory*, October 1969.

(XXVIII. NEUROPHYSIOLOGY)

4. J. E. Brown and C. E. Holt, "Pottassium Flux Changes in Response to Light in Limulus Ventral Eye Photoreceptors," Abstracts of the Third International Congress of the International Union for Pure and Applied Biophysics, M. I. T., Cambridge, Mass., August 29-September 3, 1969, p. 91.

