PHOTOSENSITIVE PIGMENTS FROM THE RETINA OF THE FROG

THE recent spectrophotometric demonstration by Wald[1] of a light-sensitive pigment from the retina of the chicken whose absorption spectrum resembles the chicken bright visibility curve, is the first direct evidence of the presence of a photosensitive substance in the cones. Since the chicken retina contains cones predominantly and differs in this respect from the retinas of many vertebrates, it seemed worth while to look again[2] for a cone pigment in the retina of the frog, whose rod-cone population is more nearly like that of man.

The retinas were treated as described earlier[3] and extracted with a 2 per cent. digitalin solution (Eimer and Amend, Digitalin, "cryst.", G 57). All operations were performed in very dim red light containing no wave-lengths shorter than 640 mμ. About 10 frogs were used for each ml of extractive.

The absorption spectrum of the solution as prepared, and buffered at pH 9.0, was measured in a depth of 2 cm, from 440 mμ to 650 mμ, using Shlaer's photoelectric spectrophotometer.[4] The solution was then exposed for 30 minutes to extreme red light, obtained with a 100 watt lamp at a distance of 6 inches, and a Wratten filter, No. 88, which transmits only above 680 mμ. After again measuring the spectrum another thirty-minute exposure was given and a third spectrum

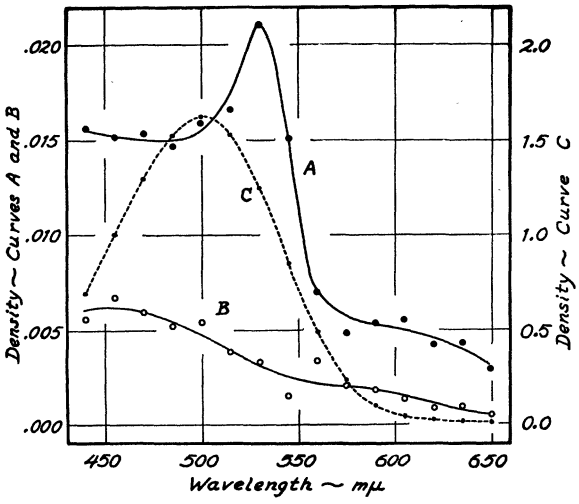

FIG. 1

recorded. Finally the solution was illuminated for ten minutes with white light and measured a fourth time.

The figure is from an experiment typical of several. Curve A results when the absorption spectrum of the solution after the first exposure is subtracted from that of the unexposed solution. This difference curve represents a light-sensitive substance or substances distinctly different from visual purple. The substance is so sensitive that even the monochromatic measuring light of the spectrophotometer causes some decomposition. Consequently, curve A may not describe exactly the absorption spectrum, but the true maximum may be farther toward the red than 530 mμ. Refinements in the procedure are necessary before its exact position can be established.

Curve B is the difference in density caused by the second exposure to red light. Practically all the substance with maximum absorption at 530 mμ disappeared during the first exposure; a further proof that it was not visual purple.

It is possible that more than one photosensitive pigment may be represented by curves A and B. On the basis of human color vision theory[5] one might expect three different substances from the cones if the frog retina resembles the human.

Curve C shows the difference in density that occurred during the ten-minute exposure to white light. This is the typical absorption spectrum of visual purple. It is significant that its concentration is considerably greater than that of the material represented by curve A, which confirms the prediction made by Hecht[5] from considerations of rod and cone sensitivity in the human eye.

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GENERAL MUSCULAR HYPERTROPHY INDUCED BY ANDROGENIC HORMONE

IN the guinea pig, the temporal muscles show a pronounced difference in size in the two sexes. In the adult female, they are comparatively small and flat; in the adult male they are much larger and can be felt as distinct protuberances over the upper part of the skull surface. This difference between the two sexes can be quite readily recognized in the normal adult animals.

In the course of experiments with gonadotropic hormone (Follutein), the temporal muscles of adult female guinea pigs underwent considerable hypertrophy. Injections of adequate amounts of gonadotropic hormone in such adult female animals over a period of several weeks resulted in an enlargement of the temporal muscles; they became rounded and protuberant much as in the normal adult male. This change was gradual and progressive and depended upon dosage and duration of treatment.

A survey of the various muscles in the treated animals showed that the induced growth was not limited

1 G. Wald, *Nature*, 140: 545, 1937.

2 W. Kühne, "On the Photochemistry of the Retina and on Visual Purple," Macmillan and Company, London, 1878 (see especially page 22).

3 S. Hecht, A. M. Chase, S. Shlaer and C. Haig, SCIENCE, 84: 331, 1936.

4 S. Shlaer, *Jour. Opt. Soc. Amer.*, 28: 18, 1938.

5 S. Hecht, Handbook of General Experimental Psychology, Clark University Press, Worcester, Mass., 1934; Chapter 14 (see especially page 793).

to the temporal muscles. Other muscles of the body were similarly affected. Comparative measurements of individual muscles and of the total amount of muscular tissue indicated that the effect is on the muscular system in general.

The temporal muscles of adult male guinea pigs, castrated before sexual maturity, remain small and flat, as in the adult females. The muscles of such castrated males did not respond to treatment with gonadotropic hormone. This treatment was likewise ineffective in spayed females. These observations indicate that the presence of the gonads is necessary for the production of muscular hypertrophy.

The microscopic examination of the ovaries of treated animals showed, among other changes, considerable hyperplasia and hypertrophy of the interstitial tissue.[1] This suggested that the gonadotropically stimulated interstitial tissue of the ovaries was responsible for the stimulating effect upon the muscles.

Various experiments were then performed in order to determine particularly the effect of the androgenic hormone. Castrated immature males and spayed as well as normal adult females were treated with androgenic hormone (Testosterone Propionate), which represents the testicular interstitial secretion. A definite hypertrophy of the temporal and other muscles of the body resulted.

In another experiment castrated immature males and adult females, both spayed and normal, were treated for a period of 6 to 8 weeks with progesterone (Proluton) and with an estrogen (Amniotin). No definite effect was observed upon the voluntary muscles. On the other hand, when androgenic hormone was combined with either the progesterone or the estrogenic hormone, a general muscular hypertrophy resulted.

In conclusion, it may be stated that the androgenic hormone has a stimulating effect upon the muscles, producing enlargement after prolonged administration. The temporal muscles show a very pronounced response. Because of their superficial position, their enlargement can be readily recognized by palpation. The source of the androgenic hormone in the normal adult male and in the gonadotropically treated female seems to be the interstitial tissue of the testicles and ovaries.

The general muscular enlargement following androgenic treatment offers an explanation for the higher muscular development of the male mammal. It also contributes to a better understanding of the more specific morphological and physiological changes associated with the androgenic action. The importance of obtaining data on the action of the androgenic hormone in conditions associated with muscular deficiencies becomes apparent.

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[1] *Anat. Rec.*, 64; 1936; Suppl. p. 16.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

EXPOSURE METER FOR CINEPHOTOMICROGRAPHY AND STILL PHOTOMICROGRAPHY

EXPOSURE meters for use with cameras and film of various types have been employed for several years. These instruments have generally consisted of some type of "barrier layer" or photronic cell and a suitable galvanometer calibrated in terms of stop opening, etc.

In this laboratory, we have been concerned with the making of still and motion pictures of microscopic subjects in black and white and in color. In the study of the capillary growth about tumor transplants under a window in the rabbit's ear, it was evident that the amount of light transmitted varied tremendously in different microscopic fields. A photoelectric cell and galvanometer system was designed for the purpose of indicating the proper exposure.

One of the first requirements was an inexpensive galvanometer of sufficient sensitivity and ruggedness, with an easily readable scale. The G–M No. 2562–A Pointer-type portable D'Arsonval galvanometer having a resistance of 1,100 ohms with a 60 mm scale and a sensitivity of 0.125 microamperes per mm division fulfils these requirements. This galvanometer is connected with the "G.E. light sensitive cell." This cell, which is small in size and weight, consists of a layer of selenium deposited on a steel plate and has an active area of approximately 1.1 square inches. Although we have not investigated many cells of this type, we find that the above combination is very sensitive and satisfactory.

A four-point switch is mounted on the unit which in one position short-circuits the galvanometer for transportation and protection. The three other points are connected to shunts which provide various sensitivities and make possible the measurement of the light intensities over a wide range. The galvanometer has three scales which are calibrated in "frames per second" for 16 mm Kodachrome film. The three ranges overlap permitting measurements from 0–60 frames per second. A master variable shunt permits the scale ranges to be adjusted for other types of film.

The photoelectric cell is mounted in a fitting which