

mitochondria in the cells of the chick embryo increase in size and divide by fission, when the cells are grown in vitro. If, as my observations indicate, mitochondria are involved in the anabolic phase of metabolism, one would expect them to grow in the cell of the chick embryo by accretion from end products of digestion absorbed by the cell; whereas in the amphibian embryo the food is stored within the cell as relatively stable substance and the whole transformation from food to protoplasm must take place in situ. So long as the cell is nourished from yolk which it contains, the mitochondria, I believe, grow upon the surface of the yolk globule. They may be certain end products of digestion, or they may be synthesized out of certain of the end products of digestion. However, before accepting this hypothesis it is important to know whether mitochondria occur in cells which have been deprived of their yolk by centrifuging. The work of Banta and Gortner,⁷ and particularly that of Jenkinson,⁸ upon the development of centrifuged amphibian eggs should be extended into the cytological field to determine wherein the mechanism is deficient in those cells which do not develop normally. Furthermore, the interpretations here offered, in so far as they relate to mitochondria, must be qualified by the consideration that their validity rests largely upon the nature of the bodies in the protoplasms which I have regarded as mitochondria. My judgment on this point is based upon the use of janus green as a vital stain and of Bensley's acetic-osmic-bichromate method, the two methods which, taken together, seem to be accepted as the nearest approximation to a specific test for mitochondria now at our command. But regardless of theoretical considerations, the observations

which have been described are, I believe, substantially correct, and they are presented in this form with the hope of stimulating interest in a field of study which affords peculiar opportunity for making a definite advance in our knowledge of the mechanics of the cell, particularly in relation to the growth of the organism.

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TRAINS OF BEATING LIGHT WAVES

IF two spectra, having the same longitudinal axis but reversed in color (*i. e.*, respectively red-violet and violet-red), are brought to interfere, the interference should occur only along the single transverse line of coincidence and therefore be inappreciable. If it is visible, then light waves of slightly *different* wavelengths, lying symmetrically on either side of the common transverse axis, must also be capable of interference in optics, in complete analogy with the case of musical beats in acoustics. After long searching I found that the occurrence of the phenomenon in question can be shown experimentally. Its scintillating appearance is exceedingly striking. It is complete within a transverse strip of the spectrum but one half to one third the width of the sodium lines. It partakes of the general characters of elliptic interferences however, except that the ellipses are now extremely eccentric (needle-shaped in other words) and confined to a single color. If the given width be regarded as the distance between two fringes and estimated as $d\lambda = 2.4 \times 10^{-8}$ cm., if x be the distance along the axis of propagation within which one reenforcement occurs, then

$$x = \lambda^2 / d\lambda = 36 \times 10^{-10} / 2.4 \times 10^{-8} = .15 \text{ cm.},$$

or the limiting group wave-length of the light waves is over a millimeter. Details and allied results, for which there is no room here, will be found in the complete paper, now in the hands of *The American Journal of Science*.

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⁷ Banta, A. M., and Gortner, R. A., "Accessory Appendages and Other Abnormalities Produced in Amphibian Larvæ through the Action of Centrifugal Force," *The Journal of Experimental Zoology*, Vol. 18, No. 3.

⁸ Jenkinson, J. W., "The Relation between the Structure and the Development of Centrifuged Eggs of the Frog," *Quarterly Journal of Microscopical Science*, April, 1914.