bar must be to the right of this line, and forked as well as the 56.6 genetic units from the left end must lie to the left of the line B.

In one of the first deletions studied genetically by Muller and cytologically by the writer, there were at least 64.5 genetic units missing from the X chromosome [the locus for prune (1) but not white (1.5) was present; the locus for carnation 65.5 was lacking but bobbed (70) was present] and this deleted X was about a third of the normal X chromosome in size. At the time of these earlier studies we did not know what proportion of the deleted X was due to the left and right hand ends respectively, but in view of the recent finding that only the tip of the left hand end is involved morphologically when 5.5 genetic units are missing, it is clear that the size of the deleted X must have been due almost entirely to the right hand end segment. The size of the deleted X is shown on the figure by the line C. Since carnation (65.5) is not present in this deleted X it follows it must lie somewhere to the left of the line C but to the right of the bar locus and that bobbed, which is present, must lie to the right. From the nature of the evidence, we can not locate carnation or bobbed more accurately at present than as indicated above, but in view of the location of ruby and of bar, one might guess that carnation would lie much closer to the bar locus than the line C.

An analysis of other cases, the data for which we can not give in this brief article, fits into the cytological map as here given. Complete cytological evidence and pertinent discussion will be presented in a longer paper now about ready for press.

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THE STRUCTURE OF PROTOPLASM

INSUFFICIENT optical differentiation between the constituent parts of protoplasm has greatly hampered the advance of knowledge of protoplasmic structure. Dark-field illumination with the cardioid condenser has helped but little. The recent invention of a dark-field oil-immersion objective by Charles Spierer[1] is a very successful forward step in indirect illumination methods, especially when applied to the study of the colloidal structure of living matter. The Spierer lens reveals a structure in living protoplasm, as it does in celloidin[1] and in the cellulose walls of plant cells,[2] which is not visible with any other optical system.

The Spierer lens is a Zeiss 1/12 inch oil-immersion objective with a small platinum mirror electrolytically deposited at the center of the upper surface of the lowermost lens of the objective system. This mirror reflects all direct light, thus producing a dark-field. The scattered (colloidal) light from the object viewed is picked up by the lens around the mirror. Increased detail results because direct light is used instead of the usual bilateral illumination of the older type of ultramicroscope. The optical principles involved and a fuller description of the lens are given in other publications.[1,2]

When the hyaline protoplasm of living onion cells is viewed through the Spierer lens, it is, under favorable conditions, seen to consist of two substances, one brightly illumined, light gray in color, and very finely granular in texture, and the other, an optically empty, black background. In quiescent protoplasm these two substances are intermixed as an emulsion and then present a mottled appearance. Protoplasm under tension, as it is when formed into a thread (Fig. 1, a),

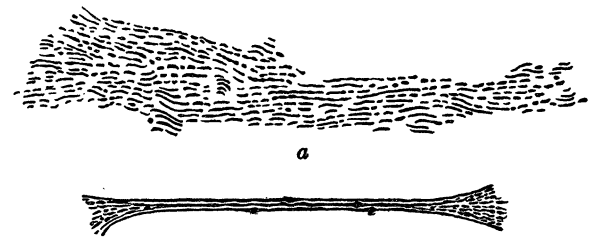

FIG. 1

or when streaming (Fig. 1, b), assumes a striated appearance, due to the parallel arrangement of long strands of the illuminated substance. These strands may be continuous (Fig. 1, a) or discontinuous (Fig. 1, b); in the latter case they are made up of rods oriented end to end. The striated structure is seen at its best in actively flowing protoplasm. Included particles occur, and appear as brilliant globules imbedded in either the gray matter or the dark intervening substance.

Without any attempt to characterize chemically or vitally the two phases which make up this dark-field structure of protoplasm, I propose calling the brightly illuminated, gray-appearing, and at times discontinuous, dispersed phase, the *phaneroplasm*, (*phaneros* = evident), and the unilluminated, black-appearing, optically empty background, or continuous phase, the *cryptoplasm* (*cryptos* = hidden). In the accompanying figure, the phaneroplasm is black and the cryptoplasm (the background) white, which reverses what is white and what is black in the actual material as seen with the Spierer lens.

Both phaneroplasm and cryptoplasm flow, though apparently not at the same rate, the phaneroplasm being more sluggish in its movement. The cryptoplasm is optically empty and can not, therefore,

1 "Un Nouvel Ultra-microscope à Éclairage Bilatéral," *Arch. Sci. Phys. et Natur.* (Genève) 8: 121, 1926.

2 "The Spierer Lens and What it Reveals in Cellulose and Protoplasm," *Jour. Phys. Chem.* 118: 35, 1931.

actually be seen; its streaming is, however, made evident by the movement of included particles. A rapidly moving particle may, where there is an irregularity in the arrangement of the striae, strike against the side of a strip of phaneroplasm; its forward movement is thus retarded, but only for a few moments while it is slowly pushed through the phaneroplasm, first thinning it, and then breaking through. This and other similar events indicate that *the cryptoplasm is the actively streaming component of protoplasm.*

The strands of phaneroplasm are from 0.3 to 0.4 μ in thickness and 0.2 to 0.3 μ apart.

Except for the optical properties already referred to, there is little to be said concerning the physical, chemical and vital nature of the two substances which make up the living hyaline diphasic system. The phaneroplasm is brightly illuminated but the cryptoplasm is not. Where the protoplasm, at rest, assumes a mottled appearance, the phaneroplasm becomes the dispersed phase and the cryptoplasm the dispersion medium of an emulsion; where the protoplasm is striated but the striae broken, the structure is still that of a (distorted) emulsion; but where continuous striae exist, there is no distinction between a discontinuous and a continuous phase, that is to say, there is no emulsion as ordinarily defined.

New terms are convenient if merely as temporary handles to be discarded as knowledge of the subject increases, but they add confusion if satisfactory old terms exist. Strasberger[3] distinguished between kinoplasm (active substance) and trophoplasm (nutritive substance), two terms which have been brought into use again by Lloyd and Scarth;[4] but these terms are not applicable to the cryptoplasm and phaneroplasm described here if Strasberger's original description is to be adhered to. He says that kinoplasm possesses a fibrous structure and trophoplasm the structure of a honey-comb, and that the two substances may be in quite distinct regions of the cell. No such differences are evident in the dark-field structure of protoplasm as seen by the Spierer lens. This lens differentiates not kinoplasm from trophoplasm, but two substances which make up the kinoplasm alone.

There does not appear to be any satisfactory correlation between the structure of actively flowing hyaline protoplasm as revealed by the Spierer lens, and structures seen and described before. The mottled emulsion structure of the resting protoplasm is, in a broad way, comparable to alveolar protoplasm as described by Bütschli, and to numerous other pseudo-alveolar, vacuolate and emulsion structures. The striated structure of protoplasm when under tension, has apparently no counterpart in the older literature.

The nearer we approach the ultimate structure of protoplasm the less easy it is to differentiate between the relative importance of its constituents, but the idea that some substances in living matter are more important than others is often entertained. If we attempt to draw a distinction between the relative "vital" significance of phaneroplasm and cryptoplasm, then, frequent discontinuity in the former and active streaming of the latter suggest that cryptoplasm is the more fundamental of the two.

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[3] "Ueber Cytoplasmastructuren," *Jour. wiss. Bot.* 30: 375, 1897.

[4] "The Rôle of Kinoplasm in the Genesis of Vacuoles," SCIENCE, 65: 599, 1927.

ON A POSSIBLE EFFECT OF FUNGICIDES UPON THE COMPOSITION OF APPLES

THERE is prevalent among the practical fruit-growers of the Annapolis Valley district of Nova Scotia the opinion that apples sprayed with sulphur fungicides do not keep as well in common storage as those sprayed with copper fungicides. Actual storage comparisons have not, however, indicated any marked difference in the rate of senescence of fruit treated with these respective fungicides as evidenced by the rate of fall of the pressure test, by the appearance of the fruit, or by its rate of spoilage. One of the workers, at present actively engaged in making storage tests of this nature, has, nevertheless, found differences in flavor sufficiently marked to enable him to differentiate (by blindfold test) unsprayed fruit from that which has been treated during the growing season with sulphur or with copper fungicides. This fact indicates that there may actually be a difference in composition induced by the repeated use of these respective fungicides during the growth period of the fruit.

In an attempt to obtain evidence of such differences the authors have recently made analyses of apples of the Northern Spy and Ribston Pippin varieties which had received various fungicidal treatments. Samples of five apples each of the former variety and of ten apples each in the case of the latter were selected from quantities of fruit gathered in connection with a study (in progress) of the amounts of sulphur and copper remaining upon the fruit at harvest under Nova Scotian conditions. This fruit had received uniform storage treatment of the common storage type since date of picking, and all samples were gathered at practically the same stage of maturity. The apples were quartered, the stems and cores removed, and the remaining tissues finely ground in a common food chopper. Samples of 25 grams each were weighed out as soon as possible after thorough mixing of the