the values of the molecular cohesions of these two compounds (70,880 and 77,220 cal., respectively).

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AN INEXPENSIVE REDUCING LENS

THE appearance of a drawing, when reduced in size for publication, is frequently altered. A reducing lens is useful in determining the size of dots and the width of lines that will give the desired effect when the size of the drawing is decreased.

An ordinary microscope slide with concave depression serves nicely for this purpose. When the drawing is viewed through the polished cavity in the slide it is reduced from one half to one third, depending upon the distance of the slide from the drawing. A further reduction may be had by placing two slides face to face so that their cavities coincide.

Culture slides with one polished concave depression, 15 or 16 mm in diameter by approximately 0.4 mm in depth, can be found in most biology laboratories, or may be had from the scientific companies for a few cents each. They make simple but effective reducing lenses.

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SPECIAL ARTICLES

THE FUNCTIONAL CHARACTERISTICS OF NINE RACES OF FIBROBLASTS

COMMON connective tissue cells, or fibroblasts, being the first to be isolated in pure cultures, have served as material for a vast array of studies from which much valuable information has been gained concerning the structural and functional properties of cells in general and of these cells in particular. For convenience, and in order that comparable results might be obtained by the various investigators, the material most generally used has been the original strain of fibroblasts isolated over 20 years ago, by Carrel, from the embryonic chick heart. Hence, the properties of these cells have become very well known. Some years ago, it was demonstrated, however, that functionally different cell strains, each of them possessing all the structural features commonly attributed to fibroblasts, could be isolated from various tissues of the same organism.[1] This disclosure, which resulted from a study of the diverse manner in which four different strains of fibroblasts reacted to a given nutritional régime, clearly indicated the error involved in confining classifications and definitions of cell types to purely morphological characters, without at the same time taking into account their physiological properties. It is believed that the additional information to be reported here will not only strengthen this view-point, but will also show the importance of enlisting as many of the characteristics of these cells as may be revealed, and of subjecting each to careful and systematic analysis, before attempting to explain the biological significance of any one of them.

Several series of experiments have recently been made in which a varying number of cell strains were isolated simultaneously from different tissues and organs of the same chick embryo and, from the very beginning, subjected to conditions which were as identical as it was possible to make them. The procedures employed were the usual ones involving the flask techniques. Very soon after the tissues were removed from the organism, the cell population was rendered uniform by continued selection of only the marginal areas of outgrowth at the time of transfer. Then, by comparing these strains with one another, and with strains from similar series derived from embryos of the same age, it was possible to detect any outstanding properties manifested under the conditions of the experiment. The particular series that has been selected for the purpose of the present communication was composed of nine strains of fibroblasts isolated from a 17-day-old chick embryo and cultivated for ten passages (56 days) on a medium consisting of chick plasma, chick embryonic tissue juice and Tyrode solution. These strains were derived from the following tissues and organs: the wall of the dorsal aorta, the periosteum of bone, the perichondrium of cartilage, the wall of the ventricle, the wall of the proventriculus, the muscles of the lower limb, the kidney, the thyroid and the testis.

Aside from making a comparative study of the rate of growth of the various tissues over the entire period of cultivation, tests were carried out from time to time to determine the relative amount of free acid that accumulated in the medium. For this purpose, a dilute solution of phenol red was added to the medium of each flask, after which the hydrogen-ion concentration was adjusted by introducing into the flask a gas mixture of O_2, CO_2 and N, these being combined in such proportions as to produce a temporary acidity of pH 7.8. The changes produced in the various cultures could then be read at 24 or 48 hour intervals by comparing them with a standard series of flasks of known pH values. Other experiments were designed to test the ability of the various races to sur-

[1] R. C. Parker, *Arch. f. exper. Zellforschung*, 8: 340, 1929.

vive and grow in an abnormally acid medium. This condition was also brought about by subjecting the cultures to an atmosphere composed of O_2, CO_2 and N, but this time the mixture contained a greater concentration of Co^2 than that which had been used to establish a pH of 7.8. Thus it was found that the various tissues differed not only in their rate of growth and in the amount of acid that accumulated in the medium in which they were cultivated, but also in their ability to survive and grow in a medium in which the hydrogen-ion concentration was artificially increased. In addition, they showed marked variations in the extent to which they were able to digest fibrin. The accompanying diagram (Fig. 1) shows

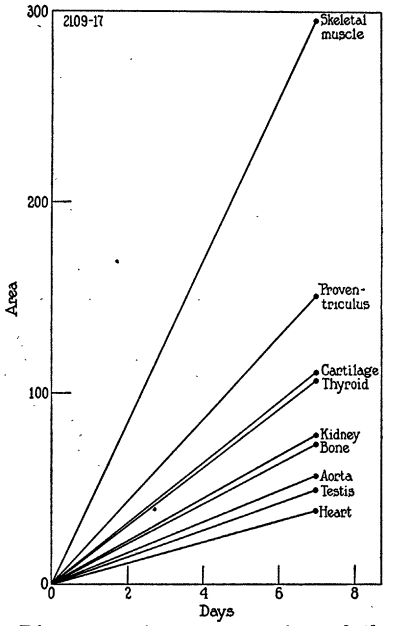

FIG. 1. Diagrammatic representation of the rate of growth of nine strains of fibroblasts isolated from a 17-year-old chick embryo and subjected to the same treatment from the beginning; 8th passage.

the relative growth rates displayed by these strains in their eighth passage. It will be seen that the fibroblasts derived from the heart muscle possessed the lowest growth energy of any of the series, whereas the fibroblasts from skeletal muscle showed the highest. In this respect, these two strains represented the extremes. Furthermore, these rapidly growing fibroblasts from skeletal muscle liberated a large amount of acid into the medium and were able to withstand a medium of high acidity. There was, however, very little digestion of fibrin. Fibroblasts from the proventriculus and the kidney, on the other hand, produced little acid, but rapidly digested the fibrin of the clot. The same was essentially true of fibroblasts derived from the thyroid, although in this case the colonies grew extremely thin, much more so than has ever been observed for other races of fibroblasts. The fibroblasts from the aorta were characterized by a large production of acid. Although their rate of multiplication was much slower than that of fibroblasts from cartilage, thyroid, kidney or the proventriculus, they produced much more acid than any of these. In spite of this, however, they grew poorly in an acid medium.

These results indicate that the common connective tissue cell, or fibroblast, does not occur throughout the organism as a separate and distinct type. Fibroblasts as a group include many different cell types. Just, for example, as the *milieu intérieur* of the thyroid is different from that of the kidney, so also are the connective tissue cells which they harbor and nourish. Hence, it seems reasonable to assume that there are as many types of fibroblasts in the body as there are tissues and organs. These various cell types were originally endowed with identical properties and potencies by virtue of a common ancestry. But as they became integral parts of developing tissues and organs, they became more and more divergent, with the final result that, when separated from the organism, they retained those qualities that they had progressively acquired as an expression of the special localized conditions under which they had lived prior to their isolation.

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