The tabulated information on composition of hay and of legumes, the structural details and particularly the drawings will prove useful additions to the existing literature on this topic. This book will prove a permanent and important addition to the literature of the world on food and food crops. It might also be said to mark the beginning of American activity in furnishing reference books of truly world scope, a function that we have been accustomed to regard as a particular prerogative of the Germans before the war. Let us venture to hope that America with her financial resources and world interest will now take her place in surveying world information.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE "MOLECULAR STILL" AS A TOOL OF BIOCHEMICAL RESEARCH[1]

THE comparatively unstable nature of many compounds often encountered in biochemical work and the frequent occurrence together in preparations of biological origin of substances of widely varying molecular complexity and weight suggest that the so-called "molecular still" should prove useful in biochemical research as a device for the distillation and purification of such compounds and for the partial or complete separation of such mixtures.

The term "molecular still" is applied to any distillation or sublimation device in which the condensing surface is separated from the evaporating surface by a distance less than the mean free path of the molecules of gas at the pressure used. Ordinarily a very high vacuum is used such as is achieved by the use of a diffusion pump in conjunction with a cold trap. Distillation by this method differs from the usual variety in that most of the escaping molecules proceed to the condenser in an unobstructed path by their own kinetic energy, instead of diffusing or being swept along in a current of gas. A suitable temperature differential is maintained between the evaporating and condensing surfaces. For the complete theory of operation and details of the various types of construction, the original papers should be consulted.[2]

The "molecular still" was first used by Brönsted and Hevesy[3] for the partial separation of the isotopes of mercury and later was suggested for the separation of the higher paraffins by Washburn,[4] who also succeeded in distilling sucrose. It since has been used by other investigators for the separation of mixtures and for other purposes.[5]

The complete absence of oxygen and the possibility of the use of low or moderate temperatures should make the molecular still particularly useful in biochemical research where substances sensitive to oxygen and high temperatures are not infrequently encountered. In this laboratory glucose, sorbitol and glycine have been distilled unchanged without difficulty at good rates at temperatures fifty or more degrees below their melting points. Vegetable oils and animal fats have been distilled.[6] Very recently Freudenberg[7] and others have succeeded in preparing methylated cellotetroses in pure form by this means. It should be very easy to separate relatively simple substances from such complex and completely non-volatile materials as proteins and the higher carbohydrates or from inorganic impurities. Where there is a propitious difference in volatility and/or molecular size between the components of a mixture, fractionation can be accomplished. Other applications of this comparatively new tool of research should readily suggest themselves in specific investigations.

On theoretical grounds it is probable that any substance can be distilled unchanged (rates are, however, often extremely slow) if the heat of dissociation of the least stable bond in it is greater than the molecular cohesion. The molecular cohesion of a compound is its molecular heat of evaporation at absolute zero, estimated by extrapolation from data obtained at higher temperatures. This property, which has been studied by Dunkel,[8] appears to be roughly additive, and the approximate value for any compound of known structure can be calculated from a table of values for the various constituent groups. In this connection it is interesting that it has been found possible to distil the normal paraffin $C_{70}H_{142}$ but not $C_{80}H_{162}$.[9] The value for the heat of dissociation of the carbon-carbon bond (ca 75,000 cal.) lies between

[1] Communication No. 99 from the Experimental Station of E. I. du Pont de Nemours and Company.

[2] Brönsted and Hevesy, *Phil. Mag.*, 43: 31, 1922; Washburn, *Bur. Standards Jour. Research*, 2: 476, 1929; Burch, *Proc. Roy. Soc. (London)*, 123: 271, 1929; Hickman, *Jour. Franklin Inst.*, 213: 119, 1932.

[3] Brönsted and Hevesy, *loc. cit.*

[4] Washburn, *loc. cit.*

[5] Burch, *loc. cit.*; Carothers, Hill, Kirby and Jacobson, *J. Am. Chem. Soc.*, 52: 5279, 1930; Carothers and Hill, *Jour. Am. Chem. Soc.*, 54: 1557, 1559, 1566, 1569, 1932; see also Hickman, *Chem. Ind.* 48: 365, 1929; E. K., *Synthetic Organic Chemicals*, 2: 3, 1929.

[6] *Synthetic Organic Chemicals, loc. cit.*

[7] Freudenberg, Friederich and Bumann, *Ann.* 494: 57, 1932.

[8] Dunkel, *Zeits. physik. Chem.*, 138, 42, 1928; see also Meyer and Mark, "Der Aufbau der hochmolecularen organischen Naturstoffe," Academische Verlagsgesellschaft, 1930, p. 23.

[9] Carothers and Hill, Kirby and Jacobson, *Jour. Am. Chem. Soc.*, 52: 5279, 1930.

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.