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CARBON DIOXIDE UTILIZATION IN ANIMAL TISSUES[1, 2]

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IF we consider living organisms in terms of their nutritional demands upon the environment in which they live, we can place the plant with its ability to synthesize all the complex components of its structure from light energy and simple inorganic substances such as carbon dioxide, water and ammonia at one extreme and the animal with its fastidious demands for preformed dietary constituents such as vitamins, certain amino acids and certain fatty acids at the other. The carbon requirements of the plant can be satisfied completely by carbon dioxide. For animals the sources of carbon are the energy-rich organic molecules of the diet, and carbon dioxide is regarded traditionally as a metabolic end product. Experimentally, this is justified in that one can demonstrate a photosynthetic uptake of carbon dioxide in plants, while with animal tissues a continuous metabolic production of carbon dioxide is observed.

The photosynthetic process can be generally formulated:[3]

(1) $CO_2 + 2H_2A + \text{energy} \longrightarrow (CH_2O) + 2A + H_2O$

[HA is any oxidizable substance: A the oxidation product of HA]

[1] Read before the American Chemical Society at Memphis, Tennessee, on April 22, on the occasion of the conferring of the Eli Lilly and Company Award in biological chemistry for 1942.

[2] The original work reported in this paper was aided in part by grants from the John and Mary R. Markle Foundation and from the Dr. Wallace C. and Clara A. Abbott Memorial Fund of the University of Chicago.

[3] C. B. Van Niel, *Cold Spring Harbor Symp. Quant. Biol.*, 3: 138, 1935.

reaction vessel can still be improved. Thus, in the determination of oxygen consumption, the accidental contamination of the contents of the vessel with alkali, which may occur when vessels of the conventional form are used[2,6] and which results in loss of the determination, can be prevented entirely by a slight change in design as indicated in the figure.

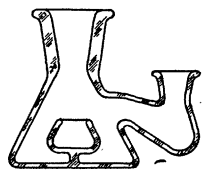

FIG. 1.

A truncated cone-shaped center cup is recommended in place of the usual cylindrical-shaped cup. The center cup in the reaction vessel of Warburg, Kubowitz and Christian[7] has a similar shape, but it is larger and it is fused to the floor of the vessel. By placing the cup on a pedestal 5 to 7 mm high, the absorbing area of the buffered solution below the cup is considerably increased. The vessel constructed as shown in the figure may be rotated rapidly back and forth through an angle of almost 90° from the vertical without any contamination of the buffered solution with the strong caustic alkali absorbent in the center cup.

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SOME NEW USES FOR THE 2 x 2 PROJECTOR

THE advantages of the small projector now used for 2×2 slides are quite obvious. They are small, easily handled and less expensive than the older types designed for the standard $3\frac{1}{4} \times 4''$ slides, and a 200 or 300 watt bulb gives good brightness. Besides this, many photographers will welcome the ease of making Kodachrome slides with a miniature camera.

These considerations have led me to experiment with microscopic objects of fairly large size, both in sections and whole mounts. Cross sections of an embryonic dogfish fixed to a 2×2 slide and suitably stained serve to show the relationship of such structures as gills, notochord, neural tube and myotomes. The brook lamprey is another promising subject, and different types of plant stems show up beautifully on the beaded screen.

Whole mounts of a wide variety of subjects may be used, from feathers to chick embryos or insects with spread wings and legs. Small leaves, cleared or skeletonized to show the veining, should offer a promising field to botanists, and I am starting some work along these lines.

In mounting material I have used the ordinary histological techniques for the most part, but prefer thin sheet plastic to glass for cover slips because it can be cut to cover the entire slide, leaving no edges to catch when filing slides. I have mounted a few sections between two sheets of this, putting them in pasteboard "Ready Mounts," but for most purposes a glass slide is preferable.

The limitations of the method are obvious. The usual mask supplied measures 23×33 mm, and nothing much larger than this can be used. It must also be plain that histological details seldom show up clearly because of the low magnification, but gross anatomical structures, like xylem and phloem or annual rings, can be seen perfectly. I have not yet tried making a water cell to use with living material like small tadpoles, algae or crustacea, but that should be practical.

In order to try some of the microscopic material in our slide collection I made a slide carrier of wood to take microscopic slides. While this is workable the dimensions of the $1 \times 3''$ slide make it much harder to handle than the 2×2. Furthermore, unless this type of slide is used exclusively the frequent changing of carriers is a nuisance. For these reasons I am making a series of 2×2 slides for use in the department.

At least one supply house is making 2×2 Kodachrome slides from stained histological material, a method that gives beautiful results with a wide variety of subjects and at a reasonable cost.

The arc lamp projector that sends a strong beam through a microscope unquestionably gives much better results for histology, but it is an expensive and cumbersome apparatus and needs complete darkness to give satisfactory results, while the 2×2 projector is portable, easily operated and shows any fairly transparent material in enough light for students to take notes.

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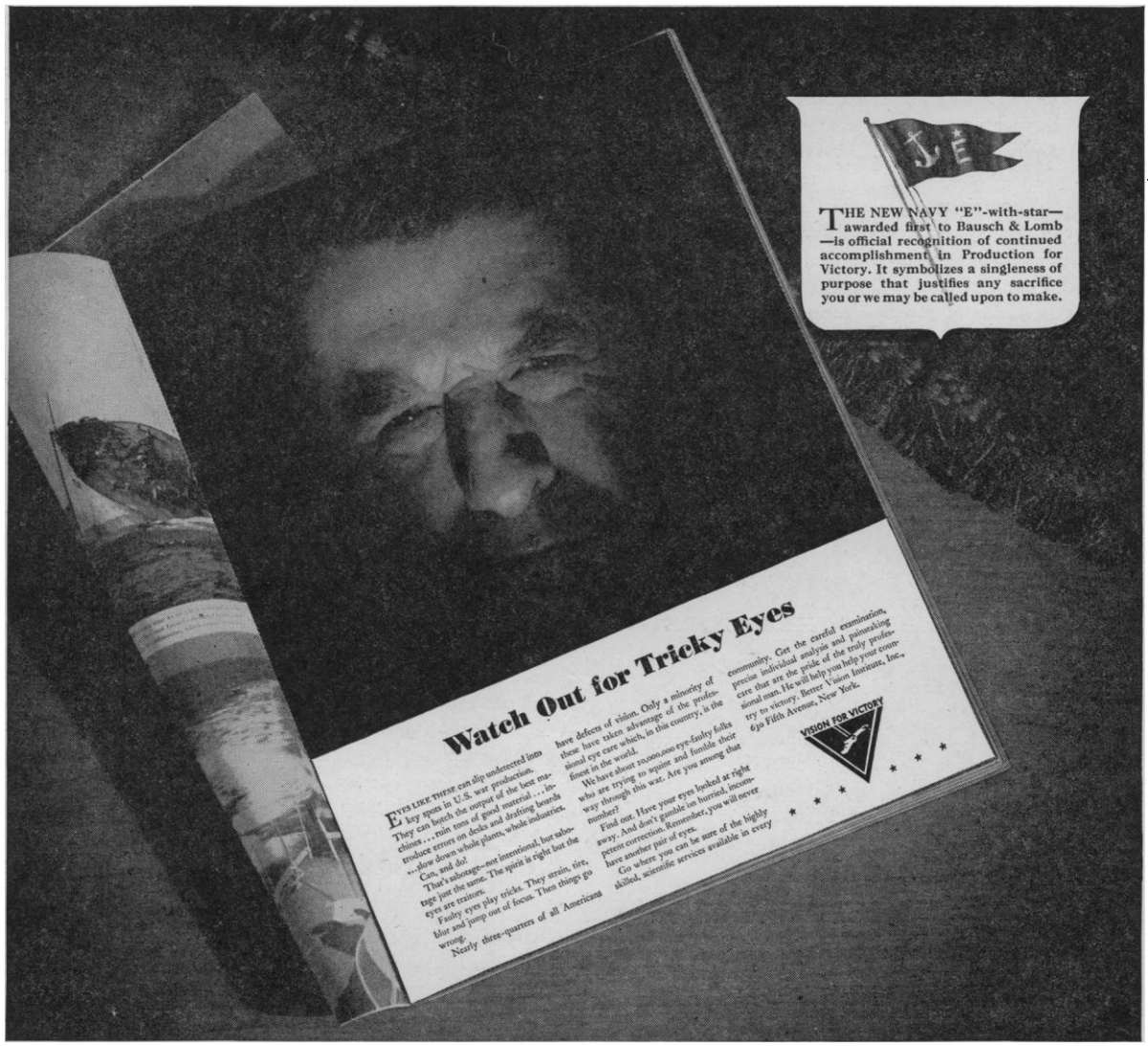
[4] R. Goodhart and H. M. Sinclair, *Jour. Biol. Chem.*, 132: 11, 1940.
[5] W. R. Johnston and C. N. Frey, *Ind. Eng. Chem., Anal. Ed.*, 13: 479, 1941.
[6] O. Warburg, E. Negelein and W. Christian, *Biochem. Zt.*, 214: 26, 1929.
[7] O. Warburg, F. Kubowitz and W. Christian, *Biochem. Zt.*, 242: 170, 1931.

BOOKS RECEIVED

Fundamentals of Radio. Edited by W. L. EVERITT. Illustrated. Pp. xiii + 400. Prentice-Hall, Inc. $5.00.

JACOBS, MORRIS B. *War Gases.* Pp. xiii + 180. Interscience Publishers, Inc. $3.00.



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