First death of adults occurred on July 12, 45 days after hatching, and 43 days later half of the adults were dead. The last adult, a male, died on October 26 at the approximate age of 152 days. Until July 31 the insects were kept in a basement laboratory having only artificial light available day and night. On that day the cage was taken to the greenhouse, where it remained till the end of the experiment. The insects behaved normally. They mated and the females oviposited in sod which had been placed on the floor of the cage.

The advantages of this method are obvious. The experimenter needs only to fill the dishes with food when necessary, provide water and occasionally remove the paper with feces from under the cages.

MYKOLA H. HAYDAK

UNIVERSITY FARM,
UNIVERSITY OF MINNESOTA

VITAMIN SYNTHESIS BY A YEAST CONVERTED FROM A HETEROTROPHIC TO AN AUTOTROPHIC HABIT[1]

Saccharomyces cerevisiae is generally accepted to be heterotrophic with regard to a number of vitamins. However, the writers have succeeded in inducing ten strains of this yeast to grow without an exogenous supply of thiamin, pyridoxin, inositol and pantothenic acid; in addition, a rich growth without even biotin has been induced in the case of at least one strain. Thus has evolved a yeast that will readily grow in a synthetic medium containing no vitamins. This building-up process of autotrophic habit was accomplished by means of prolonged incubation, by the use of a large quantity of inoculum during the initial stages and by successive transfers to solutions from which one of the essential vitamins was omitted. Ordinarily from four to seven passages sufficed to induce the yeast to grow as well in the absence of a given vitamin as it did in its presence. Then a second vitamin was omitted from the medium, and the process was repeated until a complete, or nearly complete, autotrophic habit was established.

Yeast is a good source of vitamins, but since in its turn it is dependent upon an exogenous supply of growth factors, the question arises whether or not a conversion from heterotrophic to autotrophic habit might not affect vitamin synthesis and storage and thus leave the cell devoid of vitamins. In order to answer this, the writers grew their completely autotrophic strain of yeast in a synthetic medium prepared from vitamin-free chemicals. The cultures were incubated at 25° C for four days; the ensuing crop of cells was then harvested, washed, dried and tested for the various vitamins. This was done by weighing 0.2 gram of the cells for each 100 ml of the nutrient solution, boiling for 5 minutes to extract the soluble parts, filtering, sterilizing and inoculating with the test organisms.

The following organisms were used to detect the different vitamins: *Pythium ascophallon* for thiamin; *Ceratostomella ulmi* for pyridoxin; *Lactobacillus casei* for riboflavin; *Brucella suis* for nicotinamide; *Clostridium acetobutylicum* for para-aminobenzoic acid and strains of *Saccharomyces cerecisiae* for inositol, pantothenic acid and biotin.

Two lots of nutrient solution were prepared. The first lot, containing no vitamins, was divided into two portions; the first portion was used as the control, while the other contained, in addition, the water-soluble parts of the yeast. The second lot of the nutrient medium was divided into eight portions; each portion received all the vitamins mentioned in this paper except one. For instance, the first received all the vitamins except thiamin; the second received all except pyridoxin, and so on down the list. Then each one of the eight portions was divided into halves; the first was used as the control, while the water-soluble parts of the yeast were added to the second half to furnish the missing vitamin.

The bacterial cultures were incubated at 30° C, the yeasts and fungi at 25° C. Very slight or no growth was observed in all the controls, while a rich growth was made in all solutions containing the substances extracted from the yeast cells. This indicates that our strain of autotrophic yeast is capable of synthesizing in appreciable quantities all the vitamins mentioned in this paper.

In the building-up process of vitamin synthesis, the writers have developed many strains of yeasts from a single one. Some of these synthesize and store considerable quantities of vitamins; others produce smaller amounts, or almost none. This work will appear later.

LEON H. LEONIAN
VIRGIL GREENE LILLY

WEST VIRGINIA UNIVERSITY

[1] Published with the approval of the director of the West Virginia Agricultural Experiment Station as Scientific Paper No. 278. The writers are indebted to Drs. S. A. Koser, W. G. Robbins and Robb S. Spray for some of the cultures used in this work.

BOOKS RECEIVED

American Standard Definitions of Electrical Terms. Pp. 311. American Institute of Electrical Engineers, New York. $1.00.

BROWN, F. E. *A Short Course in Qualitative Analysis.* Revised edition. Pp. vii + 367. D. Appleton-Century Company, Inc. $2.60.

CHADWICK, HENRY D. and ALTON S. POPE. *The Modern Attack on Tuberculosis.* Pp. viii + 95. Oxford. $1.00.

Collateral Readings in Inorganic Chemistry. Second Series. Edited by L. A. GOLDBLATT. Illustrated. Pp. viii + 198. D. Appleton-Century Company, Inc. $1.40.

SMART, W. M. *Foundations of Astronomy.* Pp. vi + 268. Longmans, Green and Co. $4.20.

WATSON, H. B. *Modern Theories of Organic Chemistry.* Second edition. Pp. vii + 267. Oxford. $5.00.