Together they may compare parts, thereby learning some important differences.

Second Day: Finish the models. Break the sides of the box and remove the model. Trim the rough edges. Use a razor blade or some sand paper to smooth up before painting. Poster paint with a water base is recommended for the painting. The students may want to mount their "cells" on small wooden stands.

The models should be finished before the end of class and you can test them on what they remember. Use matching exercise for instance, matching labels with descriptions.

This activity in modeling is offered as an alternate to drawing since drawings can be used at many other times. It gives the student a little better idea of the cell "cube" than a flat drawing. It may be followed by an actual microscope lesson where students can realize there are many shapes and kinds of cells.

Be sure to let the student know about other models that can be made by the same process. These are a few of them: cells showing mitosis and reduction division; red and white corpuscles; nerve cell; euglena, amoeba and paramecium; types of bacteria; animal tracks and upper and lower teeth models. The shapes can be made out of clay instead of using a box. A clay impression can be taken of the teeth and the plaster of paris poured into it. In the same way actual animal tracks may be used as molds for plaster models. A little experimentation will open new ways of making models and new subjects to be made. This activity is just a starter.

A Simple Growth-Rate Experiment For An Elementary Course in Bacteriology

ARTHUR W. JONES*
Department of Zoology and Entomology, University of Tennessee

Small institutions, often lacking in expensive equipment, can none-the-less offer courses in bacteriology which stimulate interest in the biological aspects of that science. The lack of equipment is often compensated for by simple techniques adapted to fit the particular laboratory. For instance, a group of students may easily determine some of the fundamental properties of a population growth rate. Each student is issued (1) a wooden slide box containing ten or more clean slides on each of which a square of known area is marked off, (2) a small pipette which is drawn so that one free drop equals approximately 0.01 cc., and (3) a small bottle. Each student, at his convenience, then partly fills the bottle with milk, and, after duly shaking the milk at each sampling, makes smears, using one drop of milk per given area, at regular intervals. The dried

* This paper is based on work done while the author was at Southwestern University, Georgetown, Texas.

The modification of the "Breed method" used by the author is as follows: The dried smear is fixed in methyl alcohol, then immersed in xylol to dissolve out the fat, then, after drying, stained in Loeffler's methylene blue solution (sat. sol. methylene blue in alcohol, 30 cc.; sol. potassium hydroxide, 1: 10,000, 100 cc.) five minutes, then rinsed in tapwater and allowed to dry. The bacteria can be seen as dark blue dots and rods against a colorless background, with no higher magnification than the 4 mm. objective. Bacteria are counted in several fields on a slide; the counts may be averaged and used directly to plot a growth-point, or the number of bacteria per unit volume of milk may be determined.

and stored smears are later stained after the "Breed method," and the bacteria counted. The resulting numbers of bacteria per field are plotted against time (see Fig. 1, an actual example from class data). Interpretation of the resulting curves, and their comparison with a curve based on the class' average data, provide insight into such varied matters as evaluation of statistics, dairy products examinations, and the ecology of "closed systems."

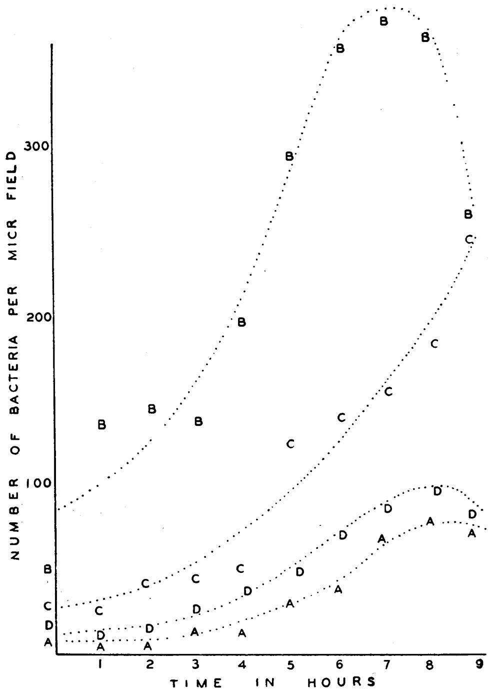

Fig. 1. Student determinations of growth rates of bacteria in milk samples. Since the Breed method of counting bacteria in milk does not distinguish between living and dead bacteria, the "maximum stationary phase" on the above curves should appear to continue indefinitely. The data, contradicting this expectation in curves A, B and D, may perhaps be explained as due to actual destruction of dead bacteria, agglutination, or similar phenomena in the rapidly changing medium.

Some Simple Physical Principles in General Biology

PAUL A. MEGLITSCH
Drake University, Des Moines, Iowa

and

JOHN P. WESSEL
Chicago City Junior College, Herzl Branch

Many students in introductory biology courses lack an adequate background in the physical sciences. This deficiency poses an important problem, namely, *the selection of material for illustrating quantitative principles.* This material should be of such a nature that it can be understood with a minimum knowledge of the physical sciences. This paper has a dual purpose: 1) to stimulate other teachers to aid in the solution of this problem and 2) to contribute some material for the teaching of quantitative concepts in an introductory course.

Some simple physical laws can be shown to have a direct bearing on the determination of the form and function of organisms. These cases serve to emphasize the importance of the quantitative viewpoint in interpreting the phenomena observed in biological studies.

Relation of Surface to Mass

One of the simplest relationships—that of surface to mass—is one of the most rewarding. That surface and mass will increase at different rates is simply demonstrated and can be understood without any background in the physical sciences. A discussion such as the fol-