The Cell and the Qubic

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A commercial game is introduced into the laboratory to help students gain a three dimensional aspect of a cell.

The study of cell structure continues to be an important part of a student's training in biology. The cell is the basic structural and functional unit in which life is both self-maintained and self-reproducible.

One of the major problems for the beginning student is the visualization of a living cell in its three dimensions. The student's two dimensional concept of cell structure interferes with adequate understanding of the necessary relationship of structure and function. Drawings and photographs necessarily present the flat aspect. Too often, drawings are generalizations of several optical sections through a single cell. The use of sectioned and stained material rather than live material as well as the increasingly flat optics of student microscopes tend to encourage the student into a misconception of the positional organization of cellular constituents.

Dillon and Johnsten (1965) have suggested an inexpensive, three dimensional model which can be used in lecture and on demonstration. Even this model, however, presents three dimensional organelles set in a two dimensional arrangement due to the limitations of the box container with a single opening. I would like to recommend the Qubic Game[1] as an inexpensive, enlarged model to be used in the laboratory. Initiation to laboratory study of cell structure by playing for half an hour several games of three dimensional Tic-Tac-Toe is a delight and a revelation to students. Trials during three years at Ripon College, Wisconsin, and the University of Illinois, Chicago Circle, have shown improvement during the laboratory session in many students' three dimensional concept of the living cell.

It is necessary that each student play several games at first. When a student has never played this game before, the first game is usually won by a series of chips in one of the horizontal planes. The second game often is won with a line of chips in a vertical plane at right angles to the playing board surfaces (Fig. 1). It takes at least three games before the student is able to plan with

[1] Available from Parker Brothers, Inc., Salem, Massachusetts.

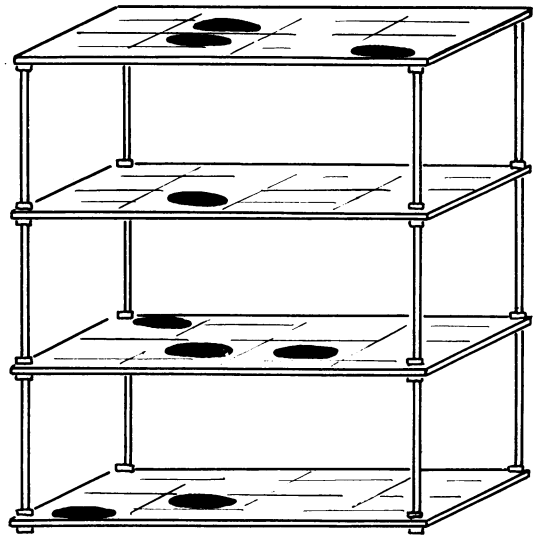

Fig. 1. The game board for three dimensional Tic-Tac-Toe provides a convenient framework for visualization of cell organization.

facility plays involving vertical, horizontal, and diagonal orientation. It often is a revelation to a student to learn how flat his thinking has been.

We then ask the student to make a drawing of the Qubic board and its contents viewed from directly overhead after a game involving twenty or more chips has been finished. Obviously, the board must be separated into its four levels ("optical sections") in order to illustrate its contents on a two dimensional sheet of paper. We try to stress continually the similarity of the study and illustration of a Qubic board with that of a living cell, specifically the leaf cell of *Anacharis* (Elodea). In this way, the meaning of "optical sections," "focus up," and "focus down" come more easily and naturally to our students.

The student is then directed to the study of the contents of the living *Anacharis* leaf cell. The cells now are recognized to have a top and bottom as well as sides—it is a "rectangular parallelopiped," no longer a "rectangle." Fortunately, even for freshmen, the chloroplasts of the *Anacharis* leaf cell move readily due to cyclosis. We ask the students to map the position and estimate the volume of the cell vacuole by following the movement of the chloroplasts within the cytoplasm. Any positional problems can easily be discussed in three dimensions by

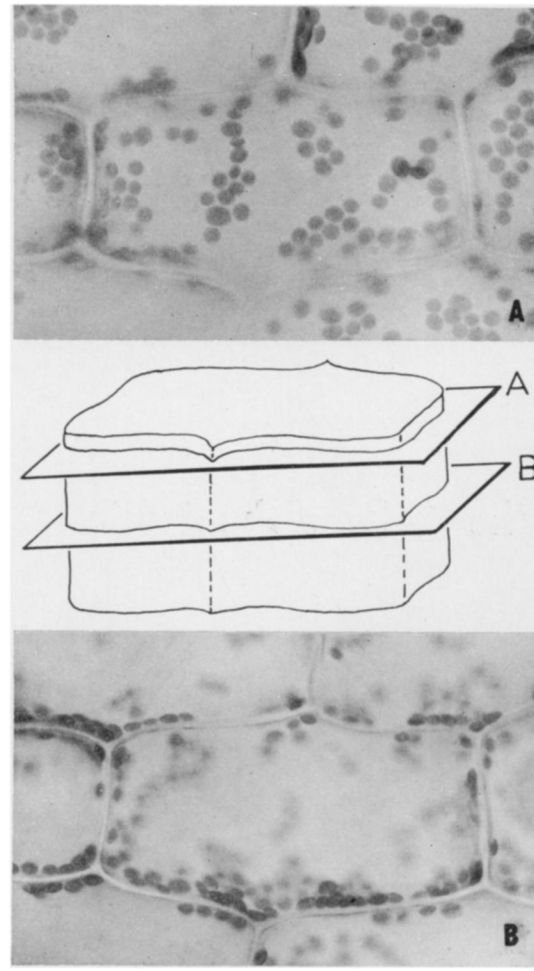

Fig. 2. *Anacharis* leaf cell with the plane of focus through the top of the cell (A) and through the center of the cell (B). Neither one of the two illustrations is more typical of the entire cell than the other.

representing the living cell with the Qubic board model and the chloroplasts with the Qubic chips.

It follows naturally that the gross structural organization of the *Anacharis* leaf cell requires two and even three separate drawings at different optical levels in the cell (Fig. 2). When students accept this fact as a matter of course, we believe we have helped them toward a better understanding of structure and function at the microscopic level—and later at the ultramicroscopic and molecular level.

Reference Cited

Dillon, R. D. and T. D. Johnsten. 1965. "3-D Cells." Amer. Biol. Teacher, 27(9):689-692.