the formation of transverse partitions. In *Nitella axillaris* a central constriction appears, which gradually draws apart forming a neck-like region before splitting in two (fig. 3). Amitosis is never followed by cytokinesis.

The possible role of microtubules in amitotic nuclear division has been suggested (Mole Bajer 1965, Pickett-Heaps 1967); however, the exact mechanism of amitotic nuclear division is not clearly understood. The significance of amitotic nuclear division to a plant or animal has not been explained.

Amitosis represents a relatively uncommon type of nuclear division that remains a little-understood nuclear phenomenon.

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SOME ADDITIONAL APPLICATIONS OF THE POPULATION SAMPLING BOARD

The idea of a population sampling board, introduced by Jerry L. Wilhm in 1967 (*ABT* 29 [6]:471), can be used to introduce students to methods of designating sampling plots and applying some statistical tests. Wilhm pointed out how this board can be used to demonstrate the concept of numerical distribution patterns in populations. His original sampling board contained data on a population of benthic macroinvertebrates taken from 100 dredged samples from a coldwater stream. The data board consisted of 100 squares, with data from one sample entered in a corresponding square.

Last summer in the NSF (COSIP-C) program for two-year college biology instructors carried out on our campus, I offered the biometrics part of a combined aquatic biology–biometrics course. We had occasion to employ the sampling board of Wilhm, and we also discovered some additional techniques which may have wide application.

The spatial dispersion of a population describes the distribution of the individuals in the population. Types of dispersion often vary with different species within a population as well as within a given species. In addition, patterns often change with time.

In general, three basic types of patterns occur: (i) random, in which there appears to be no pattern to the dispersion; (ii) regular, a uniform or even distribution of the population in which each sample square contains approximately the same number of pieces of data and the data is equally spaced in each square; and (iii) contagious, a situation in which the population has a tendency to clump in patches scattered throughout the various sample squares (as would happen in the case of the spread of an epidemic).

Three mathematical formulas describe each of these types of dispersion respectively: the Poisson distribution, the positive binomial distribution, and the negative binomial distribution. Elliott (1973) gives a rather extensive discussion of each of these types and also shows with examples how to employ chi-square tests to determine if data gathered from a number of adjacent plots actually "fit" one of these dispersion patterns. All of the tests Elliott uses can be applied to the data on the population sampling board.

In our sampling board we had the following data for our 100 squares:

1 square contained 3 different species
13 squares contained 4 different species each
29 squares contained 5 different species each
31 squares contained 6 different species each
20 squares contained 7 different species each
6 squares contained 8 different species each

To determine if the number of species in our sample data was randomly distributed throughout the 100 squares, we used the Poisson distribution. We checked our data for agreement to a Poisson (random) distribution at the 5% level and rejected the hypothesis that our data were randomly distributed. Thus, we suspected that the number of species per sample was subject to some type of pattern, either a uniform or clumped one. Similar tests are discussed by Elliott (1973) which can be used to determine if data indicate a uniform or clumped population.

An additional test for random distribution has great intuitive appeal to students. In this process, the number of 100 sample plots on the data board that contain 0, 1, 2, 3, 4, and so on, of the desired species are counted. The frequency of occurrence of these different numbers can then be checked against the predicted frequencies of a Poisson distribution via a chi-square test for goodness of fit. An excellent discussion of this method appears in Schefler (1969). We applied this technique to our data, and because our data value, chi square 36.28, is greater than 9.49, we again concluded that our data did not fit a Poisson distribution. Note that both of our methods led to the conclusion that our data were not randomly distributed.

While the use of the population sampling board was only one segment of our biometrics course, we feel it was a very succesful vehicle for introducing some of the basic concepts of statistics. In fact, the students constructed their own sampling boards and will be using them in their various colleges in their own courses.

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Short-Loop Living . . .

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lization and diversity would become accepted design concepts.

Tomorrow Can Be Better

The implications of short-loop living are far reaching. One impact could be the realization that the size and complexity of networks are not the only important criteria. The amount of flow is also important. Thus using less could become a critical value for the short-loop society.

Short circuiting networks could also contribute to the creation of shorter loops. For example, instead of eating meat which is now the end product of a long food chain involving petroleum, tractor factories, soybeans, grass, cattle food processing, butchering, and packing, the protein could be consumed in more direct forms, such as soybeans. This short-loop consumption might also serve to release food and resources for consumption elsewhere.

The most significant implication of the short-loop society could be surprising. To understand this impact it is important to look at what has happened to other visions of decentralized communities. Some of the turn of the century dreams of satellite communities, such as Sir Ebenezer Howard's Garden Cities outside of English cities like London, offered us a decentralized model. Several were actually built in England and although they were only able to provide residences for a small number of people, they did make a major contribution. In addition to providing a strong influence on urban planning, those early dreams offered a positive vision of a desirable tomorrow with people living in harmony with nature.

Given the current rampant pessimism about the prospects for the future, it may not be important that an urban greenhouse or a basement fish tank can't overnight provide us with a solution to either the world's food problems or urban instability. The fact that they exist could provide a promise that tomorrow can be better. That idea alone could be an important contribution.

The Test . . .

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B more appealing than the correct choice. The wording of choice B may have misled the students or, more importantly, a concept or idea was incorrectly learned or taught. At times I have found that students actually learned the opposite of what I thought they were learning! This type of analysis will prevent such catastrophes from being promulgated. In cases of questions which are too easy, further analysis, as for question 5, will not yield much information.

The Test: an Integrating Factor

For an examination to be a good teaching, learning, and diagnostic tool, construction must highlight levels of the cognitive domain: knowledge, comprehension, application and analysis, synthesis, and evaluation. All levels can be adequately tested by means of an objective examination. It is time that we move away from a purely knowledge examination to one which allows a student to show his true ability, not his memorizing capacity. An examination is not a marking tool, separate and distinct from a student's learning experience. With proper application of these construction and analysis techniques, we can truly test ability and understanding. A grade on an examination will become a meaningful measure of both teaching and learning, and, in the end, a means for improving both.

NABT Convention Calendar

The following are dates of seminars and conventions sponsored by the National Association of Biology Teachers. For additional information, write to NABT, 1420 N Street, N.W., Washington, D.C. 20005.

May 12–14, 1975. NABT-ICFAR Seminar, Indianapolis, Indiana.

October 23–26, 1975. NABT National Convention, The Portland Hilton, Portland, Oregon.

October 14–17, 1976. NABT National Convention, The Regency, Denver, Colorado.

October 20–24, 1977. NABT National Convention, The Anaheim Convention Center, Anaheim, California.