We are not particularly trying to "drum up" business for the GLCA Scotland Program. But we did want you to know, in all the AMCBT biology departments, that there is a school in an English-speaking country where biology majors can have the best of both worlds: they can live in a foreign culture and they can take academically solid biology courses. The application deadline for 1984-85 is March 1.

For information, contact Ms. Nancy J. Doemel, Director, GLCA Scotland Program, Wabash College, Crawfordsville, Indiana 47933, 317-362-1400 x 282.

OBSERVING AND RECORDING SKELETAL MUSCLE CONTRACTION WITH OSCILLOSCOPE AND CAMERA

Joe Kapler, Loras College, Dubuque, Iowa 52001

The frog gastrocnemius muscle is used extensively in undergraduate physiology laboratories to study the functional properties of skeletal muscle. It is convenient to use because it has a handle at both ends; the femur bone at its origin and the Achilles tendon at the other end. This muscle is easily mounted on a recording apparatus for a study of its responses to stimuli. The muscle can be stimulated directly or through the sciatic nerve if a nerve-muscle preparation is used.

We used Thornton electronic equipment, but different types and combinations can be used. The frog gastrocnemius muscle is held by a femur clamp and connected to a displacement transducer which sends signals to an amplifier and then to the oscilloscope. For the studies reported here, we stimulated the muscle directly by using fine copper wires (#32) as electrodes implanted directly in the muscle. The arrangement of this equipment is described in the Thornton Laboratory Guide to Physiology.

Single pulses from the stimulator will produce single twitches in skeletal muscle. Two successive stimuli can produce the summation effect, and a series of stimuli can tetanize the muscle if the frequency is high enough. In discussing the response of muscle to stimuli and how to best utilize our equipment to show and record these phenomena, a student offered a suggestion that proved to be quite useful. The student, John Weber, is also an accomplished musician and is familiar with electronic instruments and devices used by many of today's musicians.

One of these devices is a delay unit used for echo effects. It produces a second pulse with the same duration and amplitude as the initial pulse. We used a Boss DM-2 unit with a delay range from 20 to 300 milliseconds. This device can be switched on and off. When it is off, only the initial pulse passes through. When it is on, the second pulse produced by the delay unit follows the initial pulse from 20 to 300 ms. later, depending on the setting.

To study the summation effect in muscle, we connected the delay unit to the stimulator output and the output of the delay unit was connected to the electrodes in the muscle and to Channel B on the oscilloscope. The output from the displacement transducer and the amplifier was connected to Channel A. With this arrangement, the time of the second pulse and its effect on muscle contraction could be observed on the oscilloscope screen. Beam sweep was set at 50 ms./cm., so the time lapse between the first and second stimuli could be accurately determined.

A Thornton Type 492 Digital Storage Module can be used to store signals from the muscle response and reconvert them for oscilloscope display or to a strip chart recorder. Photographs of responses as shown on the oscilloscope screen can also be made. To do this, we utilized a Tektronix Type 516 oscilloscope and a Polaroid CR-9 camera adapted for oscilloscope trace recordings. Polaroid Type 667 film with a three second exposure at f/16 gave us good photographs. A few trials are necessary to determine proper beam intensity and
scale illumination. Utilizing the oscilloscope and camera enables students to observe muscle contraction phenomena and obtain copies of the screen image in a matter of minutes which can then be used for study and analysis. The photographs can also be copied and from the copy an overhead transparency can be made. I have found these transparencies from photographs or strip chart recordings to be very useful for classroom discussion, and they can be made in minutes after the muscle response is recorded.

![Figure 1. Two successive isotonic single twitches. The lower beam trace shows the time of the second stimulus, 92 ms. after the first. The small bump after muscle relaxation is the muscle lever rebounding.](image)

Figure 1 shows two successive single twitches resulting from the initial stimulus (4 volts for 6 ms.) which triggered the bean sweep and the second stimulus from the delay unit which came 92 ms. later. Figure 2 shows the summation effect when the second stimulus arrived 66 ms. after the first. Superimposed on this tracing is the summation effect when the second stimulus came 50 ms. after the first. In Figure 3, the muscle was stimulated for the second time at 20 ms., the shortest time possible with this unit. At first glance, it may appear to be the same as a single twitch as shown in Figure 1, but the contraction trace is 1.2 cm. higher, indicating summation. All of the responses shown in Figures 1-3 were from the same stimulus and the same frog muscle. The only variable was the time between the first and second stimuli.

The minimum delay of 20 ms. with this equipment is too long to show the refractory period of frog skeletal muscle, which is reported to be about 5 ms. In one frog, however, we were able to show the refractory period at 20 ms. The isotonic twitch resulting from two stimuli 20 ms. apart was identical to that produced by a single stimulus. It showed no summation. We attributed this to the poor condition of the frog which was one of a batch obtained in the spring of the year. The single twitch response of this frog was more than twice as long as that of a healthy frog. We have found that frogs and turtles obtained in the fall of the year are generally much healthier after a summer of activity and feeding than those which have been thought he winter hibernation. This is one of the reasons we schedule the physiology course in the fall semester.

I have recently observed that two subthreshold stimuli within a short time period will produce a response. This is shown in Figure 4. The muscle did not respond to the first stimulus (0.25 volts for 6 ms.), but the same stimulus 125 ms. later did produce a contraction, although not as strong as that from a threshold level stimulus. This appears to be facilitation or temporal summation. It is possible that the second stimulus is stronger than the first, but this is not evident where two stimuli produced two single twitches as shown in Figure 1. More study will be done with this reponse as produced by this equipment.
Figure 2. Summation effects (superimposed) from two stimuli 66 ms. (solid line) and 50 ms. (dashed line) after initial stimulus.

Figure 3. Summation of muscle contraction when second stimulus arrived 20 ms. after the first. Summation occurs before muscle relaxes.

Figure 4. Muscle response to a second subthreshold stimulus at 125 ms. after the first. No visible response to the first sub-threshold stimulus.

The summation effect can also be shown by increasing the frequency of continuous pulses, but the delay unit is particularly useful to show this effect with just two stimuli.
By reducing the time interval from 300 to 20 ms., students can see exactly where summation begins and at what point its maximum effect is attained. Thus the delay unit enhances the capabilities of recording equipment at a reasonable cost.

BIO-BYTES
Edward Cawley, Dept. of Biology, Loras College

Microcomputers are here to stay and we are all picking up large problems and small short cuts. Often these are, not important enough for a major article so they may get lost. I decided that a periodic column which would gather these ideas together for the use of the AMCBT members might be useful. I'll supply some, both original and from the literature and pass on any you send me.

"Easy editing on the Apple." or what the apple manual doesn't tell you.

It is possible to edit anything on the screen display by using the cursor move commands, (escape - followed by I, J, K, M, if your apple has auto start monitor ROM, or esc A, esc B, esc C, esc D if you do not have an autostart ROM) and then the right arrow to copy the screen. The major problems that most people have in this process is to drop the first digit from the line number or include spaces in strings which continue over one line on the screen. There is a simple solution for both of these problems. To prevent dropping the first digit from the line number be sure that you use the cursor commands to place the cursor on the first digit of the line before you use the space bar to get out of the edit mode, the right arrow will then copy the entire statement. To prevent spaces in the copied strings or to save the need to return to the edit mode to return to the left margin, use the immediate command POKE 33, 33 before you list the line you wish to edit. This will set the width of the window to the right edge of the output on the screen. You may then use the right arrow with the repeat key continuously to the end of the statement without inserting spaces into the string. After you are finished editing use a POKE 33, 40 to reset the window. Simple!

Send any tips to: Edward Cawley, Dept. of Biology, Loras College, Dubuque, Iowa 52001

VISICALC
William N. Doemel, Wabash College, Crawfordsville, IN

Visicalc is a "spreadsheet" program designed for microcomputers. Sold by Personal Software Inc., the program is available for a diversity of microcomputers including those made by IBM, DEC, Radio Shack (Tandy Corp.), and Apple. In this article, I will review the versions available for the Apple II and Apple IIe.

Why would a biologist want to purchase a program intended for business?

Business executives use Visicalc for four basic functions: (1) to perform calculations of sets of values; (2) to organize the results so that anyone can understand the data; (3) to store the data so that it can be used in the future; (4) to project future business activity. Biologists have similar needs for data manipulation and storage. We calculate data, make presentations to colleagues, store data, and form hypotheses about future