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Microscopic Digital Imaging in Introductory Biology

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K-12 instruction in biology has traditionally taken a very descriptive approach. This is in marked contrast to a quantitative as well as qualitative way of looking at things in physics and chemistry. This qualitative/descriptive approach even extends into the laboratory portion of the biological course. One way to introduce a more quantitative approach can take place is in the microscopy portion of the biology curriculum.

This area of biology ordinarily occurs first in the syllabus for several reasons. Because cellular structure is primarily a microscopic province it makes sense to introduce students to the different microscopic tools such as TEM and SEM as well as the light microscope that are used to investigate cell structure. Also, the light microscope is the principle, if sometimes only instrument, found in biology classrooms.

A typical introduction to the microscope can involve a measurement of the "field of view" as well as getting use to the various controls found on the instrument. If the lowest power student objective is 4X and the ocular 10X this measurement can occur with a fair degree of accuracy using a 6" mass-produced plastic ruler that also has a metric edge to it. Using a higher power objective would involve mathematically calculating what the field would be or using an inexpensive $15.00) micrometer. Once the student makes these calculations for 40X (4X x 10X), 100X and 400X they can record this and keep this with the microscope. At some future point if a "wee beastie" or some such thing should occupy one-half of their field under 100X then they would have an approximate size of the object.

The advent of inexpensive digital photography allows the instructor to carry out a more sophisticated approach to this exercise. Digital images of the three fields of magnification can be stored as calibrations for that microscope. A subsequent microscopic image can be digitized and the reference scale for that magnification can be cut and pasted on the image. Figure 1 on the second page shows a cheek cell that has been photographed and the relevant scale pasted on the image. This calibrated image can be printed and passed out to students as an introduction to measurement. The students would simply be given the sheets, told to work in small groups and allowed to have string and a millimeter ruler. Their goal is to determine the length of the cell. A discussion follows bearing on the accuracy of their results.

The same calibrated image can then be brought up under one of the following freeware programs. NIH Image (Macintosh), Scion Image (PC) or the new internet applet know as ImageJ. Students carrying out the above exercise in either of these applications can compare their results to what they received on the paper exercise. After calibrating their image, they can measure the area and perimeter of various structures and then compare these measurements to other ways of looking at the cheek cell like the SEM image shown in Figure 2[1]. A teacher using ImageJ can put class results on the internet and allow the students to interpret their results and write-up their conclusions after the laboratory period.

The biggest hurdle to the use of quantitative work in biology, with specific reference to digital imaging, is training teachers and the use of this technology and seeing that the exercises "fit-in" to the curricular standards.

[1] J. Ekstrom http://science.exeter.edu/jekstrom/WEB/CELLS/Epith/Epith.html

[2] J.Ekstrom *Cell Structure Study*, The Science Teacher Vol 67, No. 7, October 2000 http://science.exeter.edu/jekstrom/nsta/elodea.html

[3] J. Ekstrom Slicing for Biology, The Science Teacher Vol 68, No. 2, February 2001

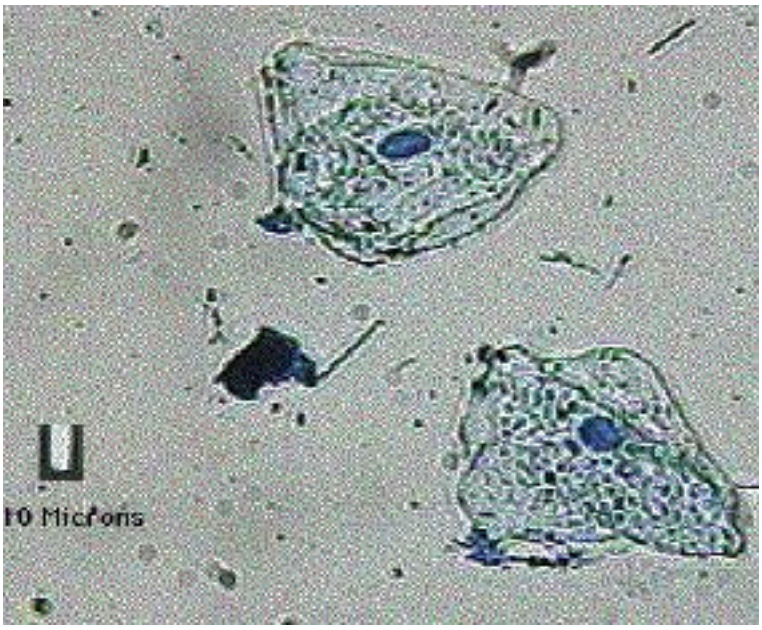

Figure 1: Cheek cells stained with methylene blue.

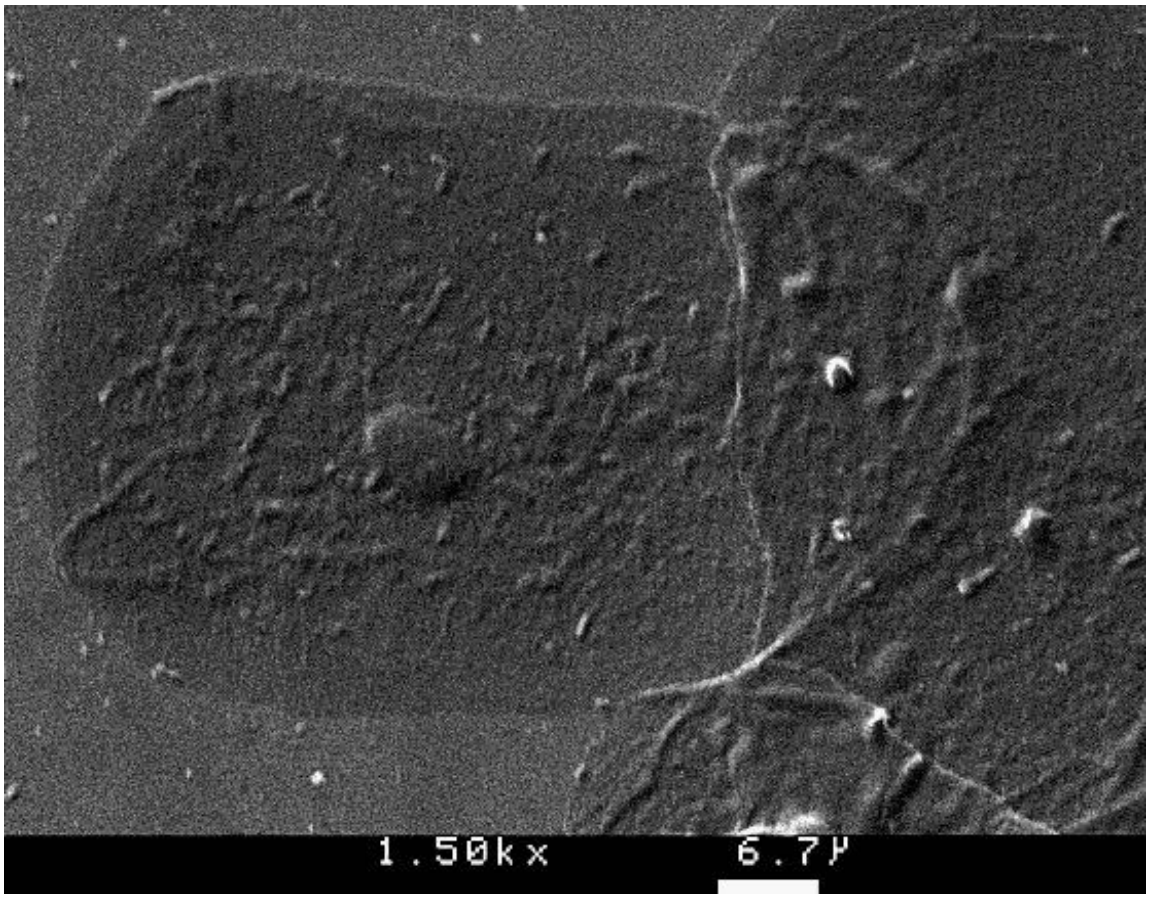

Figure 2: Cheek cells dried and sputter coated with gold.

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