Bio Currents Research Center Tutorial
Spatial Resolution

The material below has been adapted from several primary papers and reviews originating from the BRC. These should be referred to in publications and for the original source materials.

References:

1. *Smith, P.J.S., Sanger, R.S. and Messerli, M.A. (2007)* Principles, Development and Applications of Self-Referencing Electrochemical Microelectrodes to the Determination of Fluxes at Cell Membranes. In: Methods and New Frontiers in Neuroscience. Ed. Adrian C. Michael. CRC Press. Ch. 18: 373-405.
2. *Messerli, M.A., Robinson, K.R. and Smith, P.J.S. (2006)* Electrochemical sensor applications to the study of molecular physiology and analyte flux in plants. In: Plant Electrophysiology - Theory and Methods. Ed. Alexander G. Volkov. Springer-Verlag. 73-107.

Micron-sized electrodes provide good spatial resolution. For potentiometric electrodes this is defined by the surface area of the ion-selective solvent in contact with the bulk medium. The depth of sensing from the surface of a potentiometric electrode is considered negligible compared to the diameter of the ion-selective solvent interface, usually 1-4 µm. For example, if an electrode is being used to measure ionic concentration at a point near the surface of the cell, a 1-4 µm diameter electrode placed with the surface of the tip orthogonal to the cell surface will report the average concentration over the 1-4 µm tip diameter. Amperometric sensors used in constant potential mode, on the other hand, possess a sensing field that extends out into the medium away from the electrolytic surface. Take for example the O_2-sensing electrode. The electrode generates current by reducing O_2 at its sensing surface. Reduction of O_2 consumes O_2 in the region immediately in front of the tip creating an O_2 depleted zone. These O_2 depleted fields have been modeled for both macro and microelectrodes with recessed and/or coated tips.[3,4] Carefully constructed electrodes, with recessed electrolytic surfaces and/or coatings, will limit the extent of this O_2 depleted field keeping the depletion zone restricted close to the tip. A well-constructed electrode can have virtually the entire O_2 depleted zone located within the recess at its tip. Therefore, the choice of design and construction of amperometric electrodes will have the greatest influence on defining the sensing zone.

Literature Cited:

3. *Schneiderman, G., and Goldstick, T.K. (1976)* Oxygen fields induced by recessed and needle oxygen microelectrodes in homogenous media, Adv. Exp. Med. Biol., 75, 9-16.
4. *Schneiderman, G., and Goldstick, T.K. (1978)* Oxygen electrode design criteria and performance characteristics: recessed cathode, J. Appl. Physiol., 45, 145-154.