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What is a Micromanipulator - 1

This issue of NARISHIGE WEB NEWS returns to the basics and discusses the fundamentals of micromanipulators.

Invention of the Microscope and Micromanipulator

It is said that the first microscope was invented in 1590 by Zaccharias and Hans Janssen, a father and son from the Netherlands. The invention of the microscope created the largest impact on biology and led to the discovery of microorganisms and cells. However, at that time, microscopes were used for observations only.

An early microscope

Naturally a new desire came about to physically interact with cells while observing them. However, cells are too small to touch with fingertips. The fingertip is too rough to access such an intended location. Finger tremors are magnified in the view of a microscope.

Therefore an instrument was invented to minimize movement. This instrument is the micromanipulator.

Transition of the Micromanipulator

Early micromanipulators reduced movement by a simple change in the ratio of movement with the aid of different gears or by a changed torque motion of a screw to linear. These types of micromanipulators are called mechanical micromanipulators. The invention of the mechanical micromanipulators enabled examination of electrical signals of cells, reactions to chemical and performing microinjection.

Subsequently, as studies advanced to smaller cells and the ability of microscopes was enhanced, a higher demand evolved for micromanipulators. When control knobs directly combined to the manipulator's body were rotated, vibration was found in a higher magnification. To improve this problem, the mechanical micromanipulators were modified to create movement without direct knob operation on the manipulator's body with the aid of hydraulic pressure of water or oil. These are hydraulic micromanipulators that enable control in high magnification without disturbance of hand vibration.

Diversification of the Hydraulic Micromanipulator

The invention of hydraulic micromanipulators was such a milestone. However, it still had several issues that needed to be improved. First, water and oil in a hydraulic system can evaporate and deteriorate over time. Second, volume changes of water and oil in temperature fluctuation can result in drift occurrence. To improve these issues, micromanipulators were further modified according to their intended uses.

The first intended use was for microinjection purposes such as ICSI and somatic cell cloning. Micromanipulators for this purpose require excellent operability and performance for catching a floating cell and sperm. To best meet this purpose, joystick-type hydraulic micromanipulators were developed to create movement in a horizontal plane. Joystick controllers allow intuitive operation of the micromanipulators and are now very common for microinjection purposes, particularly for ICSI.

The second intended use was for electrophysiology purposes. This application does not require quick movement. However, it requires secure movement to an intended location and an electrode must maintain the position to record signals continuously. Minimizing drift occurrence is crucial in electrophysiology, thus water is employed to a hydraulic system due to its low thermal expansive characteristics. Vernier type controllers are common to reduce the possibility of erroneous operation of control knobs. Furthermore, different variations were developed, for example, 5:1 cartridge models which reduces the influence of volume fluctuation (while reducing working distance).

Hydraulic manipulators were differentiated into two directions and then improved to meet particular requirements and demands in each field.

*Reference: Microscope (Nov 7, 2011 17:16 UTC) In Wikipedia: The Free Encyclopedia.
<http://ja.wikipedia.org/wiki/%E9%A1%95%E5%BE%AE%E9%8F%A1>

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