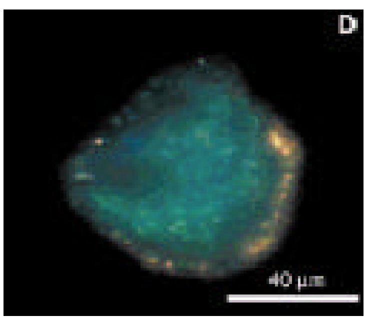
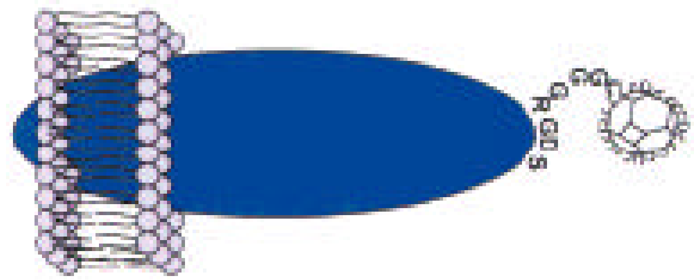
SEMICONDUCTOR-CELL INTERFACES

Quantum-Dots
By
Aaron Ball

In addition to tissue engineering approaches (my last talk), there exists a need to develop bio-prosthetics or bio-electronics that can be used to enhance or replace tissue functions.
First among these tasks is the point of connection between engineered semiconductor materials and cells (neurons).
My talk will focus on Quantum dots as this interface. Quantum dots are nanometer particles that have extraordinary optical properties. Quantum dots absorb light, then quickly re-emit the light but in a different wavelengths thus a different color. Because Quantum dots minute size and color properties they are a perfect candidate for imaging and this is there primary use. Pictured below Q-dots attracted to a cell.



Interfacing of objects and cells using bio-recognition molecules, such as antibodies and peptides, has been investigated extensively in the past (I will not investigate further). Recognition molecules have been utilized to attach a variety of objects to cells, such as dyes and enzymes. However, none of these molecules is capable of interacting electrically with cells to provide stimulation. However Quantum dots do not only absorb and re-emit light they also experience an electron hole separation when optically activated, and thus produce a electric field. If strong enough this could produce a stimulus.
There are currently two approaches in connecting semiconductor quantum dots and neurons. Firstly the antibody antigen recognition, and secondly peptide recognition. Both of these methods target receptors on the neuron surface, and localize semiconductor binding to the exterior of the cell.



With antibody antigen recognition the relatively large separation between the cell and the Q-dots leads to poor electronic coupling. Since these devices operate primarily through induction (the movement of separated charges). In order to achieve a stronger signal, small separation distances are required or a larger field is needed. Using peptide recognition semiconductor q-dots can be positioned within nanometers of the cell surface.
As previously mentioned Quantum dots experience an electron hole separation when optically activated, this produces a electric field . If an electric field is strong enough, an induction response may induce changes in the cell potential. And thus create an action potential; These electric fields can create responses in nerve cells or measure existing signals, leading eventually to a device that could communicate with the cell or nervous system.

References

Recognition Molecule Directed Interfacing Between Semiconductor Quantum Dots and Nerve Cells** By Jessica O. Winter, Timothy Y. Liu, Brian A. Korgel,* and Christine E. Schmidt*
http://www.bme.utexas.edu
http://www.wired.com
http://www.qdots.com