Bioelectronics: Progress toward drug screening with a cell–transistor biosensor

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To develop selective measurement techniques for diagnostics, drug research, and the detection of poisons, researchers would like to combine the high specificity of biochemical reactors with universal microelectronics.

Now, researchers at the Max Planck Institute for Biochemistry in Martinsried/Munich have shown that such bioelectronic hybrid systems are no longer just a utopian vision. In the journal *Angewandte Chemie*, they describe the coupling of a receptor to a silicon chip by means of a cell–transistor interface.

Many receptors are coupled to ion channels within cell membranes. When the corresponding ligand binds to its receptor, the channel is opened, allowing ions to stream into the cell. With a few tiny electrodes (the patch-clamp technique), this stream of ions can be measured; however, this technique destroys the cell. A team headed by Peter Fromherz has now proven that things can be different. Their novel, noninvasive sensor involves coupling of the ion stream directly to a microelectronic device by means of a direct cell–chip contact.

Their test subject was the serotonin receptor, a protein that resides in the membrane and plays an important role in the nervous system. Blockers specific to this receptor are used clinically to reduce the nausea that results from chemotherapy and for the treatment of irritable bowl syndrome. The scientists allowed cells with many serotonin receptors in their membranes to grow onto a silicon chip with a linear arrangement of

many transistor switches.

For measurement, a cell that covers the tiny gap (gate) of one of the transistors must be selected. The voltage in this cell is controlled with a special electrode. If serotonin is then applied, the ion channels open; a stream of ions flows along a narrow gap between the cell and the chip into the cell. The resulting signal in the transistor voltage is proportional to the current across the membrane.

By using a variety of serotonin concentrations, a dosage–effect relationship can be determined. The application of new potential receptor blockers allows their effectiveness to be quickly and easily evaluated by means of their effect on the transistor signal. “With this coupling of a ligand-steered ion channel to a transistor at the level of an individual cell,” Fromherz says, “we have laid the foundation for receptor-cell–transistor biosensor technology.”

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