A NonStop Biosensor

cen.acs.org/articles/91/i49/NonStop-Biosensor.html

REAL-TIME ANALYSIS

Watch Video At: https://youtu.be/nNTQBGJxR9Y

Credit: H. T. Soh Laboratory/C&EN

This animation explains how an aptamer-based biosensor measures a mouse's blood drug levels continuously.

A biosensor that could continuously measure drugs and biomolecules in the blood of living patients promises to aid early diagnosis of disease and help physicians customize drug doses to individuals, a key goal of personalized medicine.

The technology has been used to monitor drugs in live rats and human blood but not yet in people. However, "in the wide, deep sea of silly biosensors that don't stand a chance of ever working in practice, this one is the real deal," comments biosensor expert Richard M. Crooks of the University of Texas, Austin, who wasn't involved in the study.

Biosensors for specific drugs and biomolecules in body fluids have long been available, but most do single measurements. Continuous monitoring is currently available for only a few analytes, such as glucose, lactose, and oxygen.

Devices for continuous measurement of a wider range of target molecules in blood could help detect the onset of diseases and optimize drug dosing. But creating them is a tall order. They would have to operate without sample preparation, be sensitive and selective enough to analyze targets reliably at low levels in complex matrices, and resist fouling from body fluids.

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Credit:
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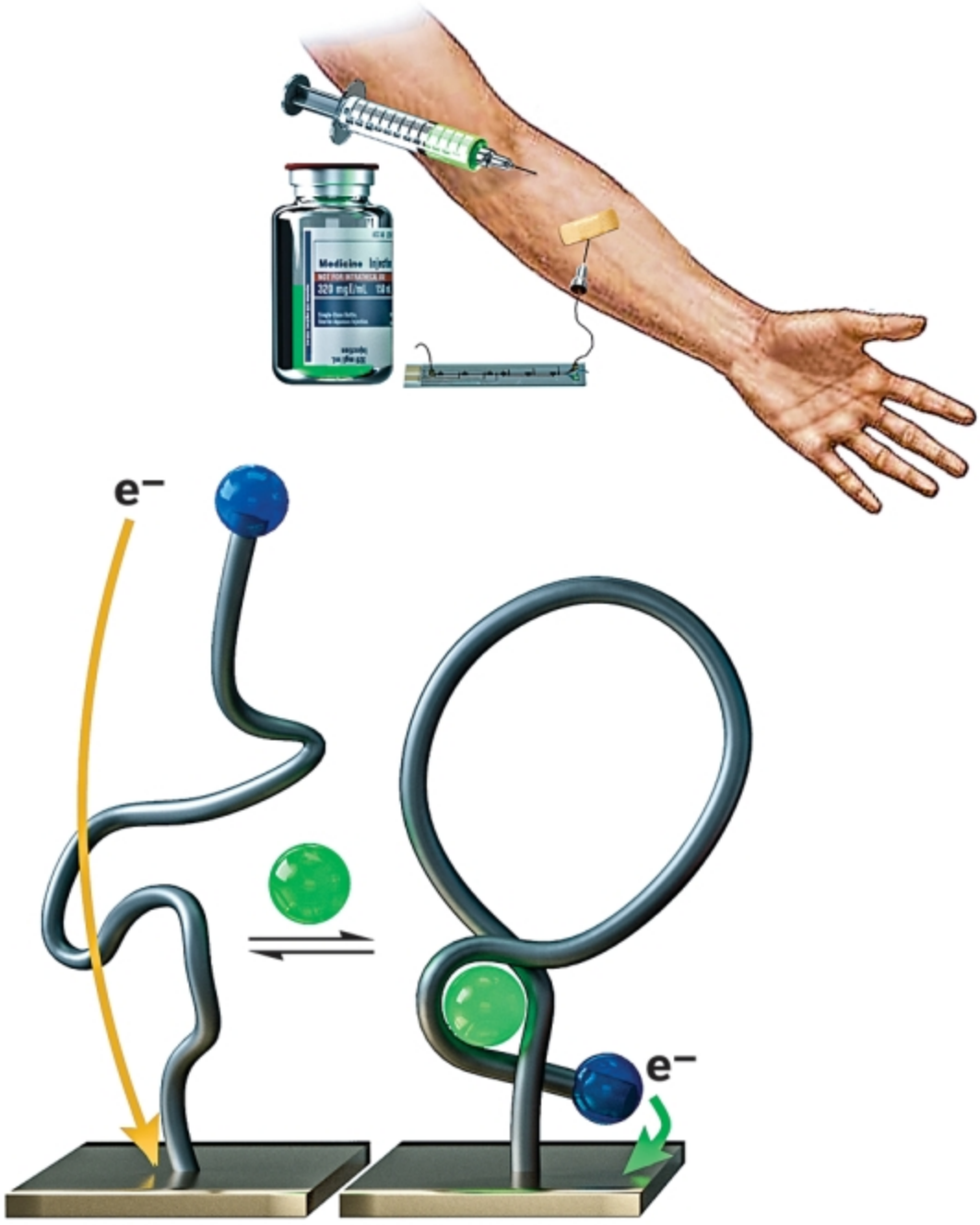

MEDIC chip (top) would be connected to patient's bloodstream to continuously measure a target drug. Inside the device (illustrated at bottom), binding of target (green sphere) to aptamer (gray) causes shape change that boosts electron-transfer rate (curvy arrows) from an electrochemical reporter (blue) to gold electrode (rectangular base), generating detection signal.

MEDIC (microfluidic electrochemical detector for in vivo continuous monitoring), devised by Brian Scott Ferguson and professor Hyongsok (Tom) Soh of the University of California, Santa Barbara, and coworkers, meets those requirements (*Sci. Transl. Med.* 2013, DOI: 10.1126/scitranslmed.3007095). It is based on an electrochemical approach demonstrated earlier by Soh's UCSB collaborator Kevin W. Plaxco and coworkers.

The device relies on aptamers, single-stranded nucleic acids that bind target molecules selectively. The aptamers are modified at one end with a redox molecule and then tethered at the other end to an electrode. When a target molecule binds, the aptamer changes shape. The change increases the current that flows from the redox agent to the electrode, generating an electrochemical signal proportional to concentration. A layer of flowing buffer lets analyte molecules reach the sensor but prevents other blood components from fouling it. The device is reconfigured for different targets by swapping aptamers.

Soh and coworkers demonstrated the system by using it to measure therapeutic levels of the cancer drug doxorubicin and the antibiotic kanamycin in live rats and in human whole blood for hours, at intervals shorter than 60 seconds. It could conceivably be used to monitor hospital patients with intravenous lines, but the researchers hope a portable version can also be developed.

Aptamers have been difficult to develop, but Soh notes recent improvements in this area.

"The truth is that I am jealous as hell of this achievement," Crooks says. "I would dearly love to have thought of this idea myself. It is clever with a capital *C*."

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