Researchers create artificial enzyme for fast detection of disease-related hormone in sweat

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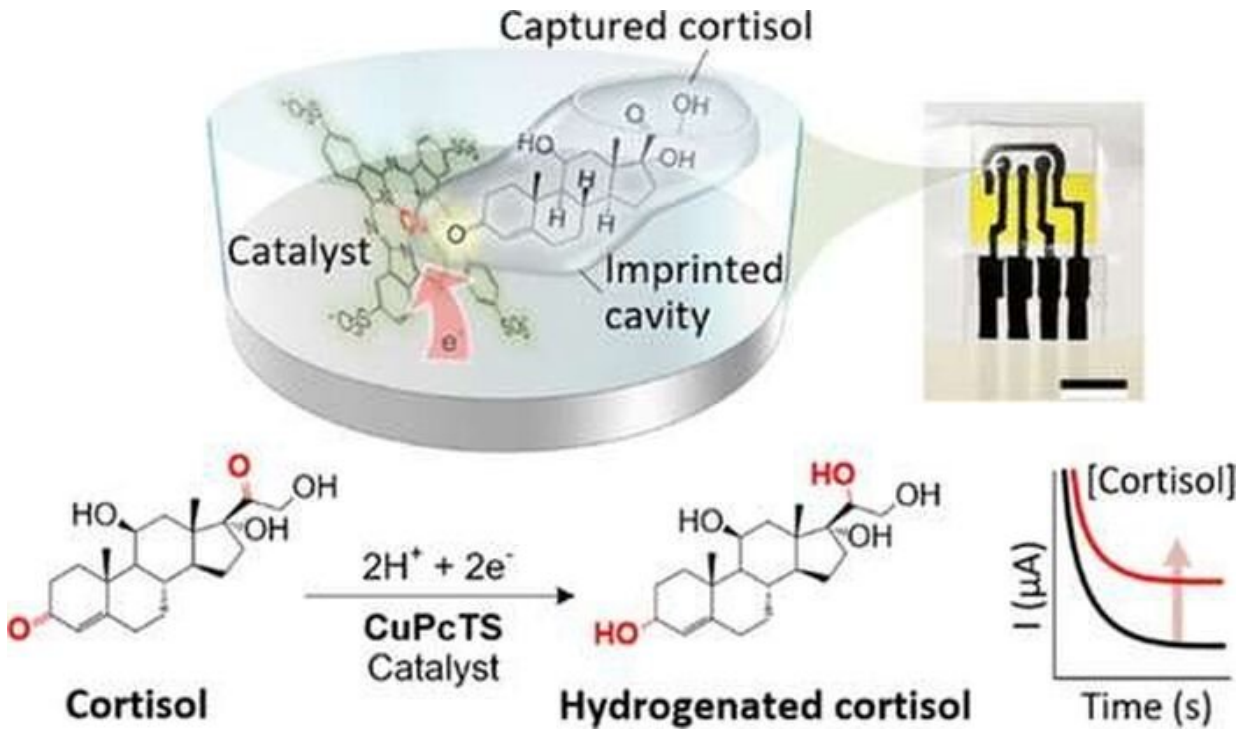

Graphical abstract. Credit: *ACS Applied Materials & Interfaces* (2023). DOI: 10.1021/acsami.2c21980

Researchers in the Oregon State University College of Engineering have developed a handheld sensor that tests perspiration for cortisol and provides results in eight minutes, a key advance in monitoring a hormone whose levels are a marker for many illnesses including various cancers.

Findings were published in the journal *ACS Applied Materials & Interfaces*. The material and sensing mechanism in the new device could be easily engineered to detect other specific hormones, the researchers say—for example, progesterone, a key marker for women's reproductive health and pregnancy outcomes.

"We took inspiration from the natural enzymes used in blood glucose meters sold at pharmacies," said Larry Cheng, associate professor of electrical engineering and computer science. "In glucose meters, specific enzymes are applied to an electrode, where they can capture and react with glucose molecules to generate an electrical signal for detection. However, finding natural enzymes for cortisol detection is not straightforward, and natural enzymes are prone to instability and have a short lifespan."

Enzymes are substances made by living organisms that act as catalysts for biochemical reactions. To overcome the challenges posed by natural enzymes, Cheng and Sanjida Yeasmin, a doctoral student who led the study, created a stable, robust artificial enzyme capable of sensitive and selective cortisol sensing.

Cortisol is a hormone produced in the adrenal glands. Hormones are the body's chemical messengers, and cortisol is one of the steroid hormones, along with androgens, estrogens and progestins. Steroid hormones play a role in several physiological processes including sexual development.

Among its jobs, cortisol assists in fighting infection, maintaining blood pressure and regulating blood sugar and metabolism, and it is nicknamed the "stress hormone" because it is released when people find themselves under pressure.

Cortisol is beneficial for dealing with stress in the short term, but prolonged periods of high cortisol levels can have harmful effects on the

body, such as an increased risk of anxiety, depression and heart disease.

"In a healthy individual, cortisol levels rise and fall depending on time throughout the day," Yeasmin said. "They are usually higher in the morning and lower at night—that means if you're going to effectively monitor cortisol, fast and frequent measurement is needed."

Cortisol levels are most commonly detected through blood or urine testing in a clinic, "which requires laboratory equipment and trained personnel and takes over 30 minutes to complete the measurement," she said. "Additionally, patients typically have to wait more than two days to receive the results."

To address those problems, Yeasmin and Cheng created an "enzyme mimic sensor" that avoids the most expensive and time-consuming elements of conventional cortisol testing.

"This sensor is natural enzyme free, label free and redox signaling probe free," Yeasmin said. "It is a robust and integrated sensor that can be applied for point-of-care applications—like at someone's bedside, outside a lab setting—and even for wearable applications. Our new sensor is more sensitive and selective than most reported sensors and, therefore, more reliable for stress hormone monitoring."

The artificial enzyme is a special polymer with tiny spaces shaped to fit only cortisol molecules. These spaces are surrounded by catalysts that make cortisol react, producing electrical signals. By measuring the signals, the amount of cortisol present can be determined, an important diagnostic tool.

Cortisol levels that are too high or low may indicate an adrenal disorder such as Addison's disease, characterized by abdominal pain, abnormal menstrual periods, dehydration, nausea and irritability, or Cushing's

syndrome, which can cause weight gain, mood swings, muscle weakness and diabetes.

"The sensor can detect cortisol levels in sweat within minutes, even when they are typically 10,000 times less concentrated than glucose levels in the blood," Cheng said. "The artificial enzyme used in this technology opens up new avenues for developing future wearable sensors for health monitoring."

More information: Sanjida Yeasmin et al, Enzyme-Mimics for Sensitive and Selective Steroid Metabolite Detection, *ACS Applied Materials & Interfaces* (2023). DOI: 10.1021/acsami.2c21980

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