

NIH News in Health

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Biosensors and Your Health

What's Your Body Trying to Tell You?

Your body alerts you to many aspects of your health. Your stomach growling tells you when to eat. A powerful yawn lets you know you're tired. Your body gives off many other valuable signals, but requires technology to detect them. Scientists are looking for new ways to track and use your body's signals to improve your health and manage disease.

Physical activity trackers and step counters are now helping people develop and maintain healthy habits. These devices have also opened doors for people to participate in health research. Now, researchers

are designing more advanced devices called biosensors that measure biological, chemical, and physical signs of health.

"The variety of biosensors used by researchers, clinicians, and people from every walk of life is growing," says Dr. Šeila Selimović, a biosensors expert at NIH. "Some speed up test results so treatments can be started promptly. Others provide the benefits of continuous monitoring of health conditions. [Biosensors] function in fascinating ways. [They use] chemical attraction, electrical currents, light-detection systems, and compact wireless-sensing technologies."

The mercury thermometer is one of the earliest biosensor technologies used in medicine. In modern thermometers, mercury has been replaced by safer temperature-sensitive probes. But the goal is still



the same: to detect changes in your body temperature.

Another common biosensor used at home is the pregnancy test. Home pregnancy tests use color-changing strips to detect pregnancy hormones in urine. Pregnancy tests are still done in doctor's offices. But the home test has become a reliable alternative since it was first introduced more than 40 years ago.

The rapid strep test is another commonly used biosensor. If you have a sore throat, your doctor may want to use one to test for bacteria called streptococci. The rapid strep test can provide results from a swab of the back of your throat in a few minutes—with 95% accuracy. Your doctor may still send a throat swab to a lab to confirm a positive test result. But they can use the rapid test results to start treatment immediately.

In parts of the world where public health care isn't readily available, researchers hope to introduce rapid tests for people living in remote regions to test for infections like influenza, HIV, and hepatitis C. New biosensor technologies can now be combined with smart phone cameras and wireless signaling. These advances make health tests more portable and affordable than lab-based equipment.

Biosensors can also be used to continuously monitor a health condition. Blood-oxygen monitors

are now found throughout hospitals and in patients' homes. These devices detect changes in the level of oxygen in the bloodstream. A rapid drop in oxygen can cause brain injury and requires quick medical attention. Blood oxygen monitors are ideal for people with lung and heart conditions, those undergoing anesthesia, or those being treated in intensive, neonatal, or emergency care. Other biosensors can be used to continuously monitor your blood

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sugar levels (for managing diabetes), blood pressure, or heart rate.

Flexible sensors are making even more types of monitoring possible. A team of engineers, led by Dr. Patrick Mercier and Dr. Joseph Wang at the University of California San Diego, is developing a flexible sensor that measures blood alcohol levels. It looks like a temporary tattoo. The sensor releases a sweat-promoting chemical into the skin and detects alcohol in the sweat. The sensor then



Wise Choices Biosensors of Today

Biosensors are already used for many health issues. They can

- continuously detect your blood pressure without a blood pressure cuff
- help a person with diabetes maintain safe blood sugar levels without a finger prick
- advise a doctor on whether to start a patient on an antibiotic treatment for strep throat
- tell whether a woman is pregnant
- record the levels of oxygen in a patient's blood without a lab test
- sense the amount of alcohol in a person's system from their skin
- diagnose patients in low-resource areas that don't have lab facilities

sends the information wirelessly to a laptop or mobile device. Similar devices are being developed by other groups to monitor cystic fibrosis and other diseases and conditions.

At the University of Minnesota, a group of researchers led by Dr. Michael McAlpine has developed inks for 3-D printing sensors that are flexible, stretchable, and sensitive. These sensors can be used to detect human movements, such as flexing a finger. They can be printed directly onto skin and used to detect body signals, like a pulse. They can also detect chemicals in the environment and be used to warn of hazards.

NIH also supports research to use sensors to gather data about environmental and other factors involved in childhood asthma. These sensor systems monitor what children are exposed to and their body's reactions. For example, Dr. Zhenyu Li, a biomedical engineer at George Washington University, is developing a sensor that can be worn on a child's wrist to detect formaldehyde, an air pollutant that can trigger asthma.

"Researchers don't have tools at the moment that can monitor environmental triggers, physiological responses, and behavior without interrupting normal activities," Li says. There are many different asthma triggers, he explains. He expects to have a wearable sensor prototype that he and his clinical partners can begin testing with patients. He's also working on a device that can be



Web Links

For more about health sensors, click the "Links" tab at: newsinhealth.nih.gov/issue/Jul2017/Feature1

placed in a child's home to detect multiple air pollutants, like those found in tobacco smoke and some manufactured wood products, such as flooring and furniture.

Biosensors can be placed inside your body as well. Dr. Natalie Wisniewski, a biomedical engineer at a medical device company in San Francisco called Profusa, is developing miniature sensors that can be injected under the skin. These sensors automatically track chemicals in your body without drawing blood. They continuously scan multiple factors at once. Normally, you need to stay in a hospital to have your body chemistry continuously monitored. With this technology, information about the chemicals in your body could be accessed around the clock, from anywhere.

Once placed under the skin, such biosensors can last for months to years. They can monitor various body functions through chemical changes. All this information can be collected on a cell phone app and shared with your physician, a caretaker, or anyone else you choose.

"Health sensors have the potential to dramatically improve the way we practice medicine and shift the focus away from reactive treatments to preventive maintenance," Wisniewski explains.

Biosensors are quickly becoming part of our normal health care routines. New sensor technologies are opening avenues to better health. Researchers are working to develop the biosensors of tomorrow. These could provide access to better health in ways we can't yet imagine. ■

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National Institutes of Health

Office of Communications

& Public Liaison

Building 31, Room 5B52

Bethesda, MD 20892-2094

[nihnewsinhealth@od.nih.gov](mailto:.nihnewsinhealth@od.nih.gov)

Tel: 301-451-8224

newsinhealth.nih.gov

Editor Harrison Wein, Ph.D.

Managing Editor Tianna Hicklin, Ph.D.

Contributors Alan Defibaugh (illustrations), Raymond MacDougall, and Geri Piazza.

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Struggling to Sleep?

Don't Let Apnea Steal Your Sweet Dreams

Most people who have sleep apnea don't realize it. That's because this disorder only occurs during sleep.

Sleep apnea is when you have pauses in breathing while you're asleep. These pauses can last from seconds to minutes. You may have difficulty breathing a few times or dozens of times an hour.

These breathing pauses can be dangerous if they cause the oxygen level in your body to drop or disturb your sleep. When oxygen drops, your brain does whatever it can to get you to resume breathing. And then you may snore, gasp, snort loudly, or make a choking sound. A family member or bed partner might be the first to notice these disruptions in your sleep.

Sleep apnea is a common disorder. Anyone can develop it. "Sleep apnea can occur in both genders, in all races and ethnicities, and in people of all sizes and shapes," says Dr. Michael Twery, a sleep expert at NIH.

The most common type of sleep apnea is called obstructive sleep apnea. Any air that squeezes past a

blocked airway can cause loud snoring. When you're awake, the muscles in your throat help keep your airway stiff and open. In adults, the throat muscles and tongue can relax during sleep, or fat tissue in the neck can narrow your airway to cause an obstruction. In children, the airway may become blocked if their tonsils are so large they obstruct the airway opening.

The other type of sleep apnea is central sleep apnea. In central sleep apnea, the brain doesn't send the correct signals to your breathing muscles, so you stop breathing for brief periods.

So how can you tell whether you may have this disorder? One of the most common symptoms is excessive daytime sleepiness. "Anyone who feels so tired on a regular basis that this is a drag on their daytime function—that even if they allow enough time to get enough sleep on a regular basis and they still feel this way—then they need to discuss it with their doctor," Twery says.

Another common symptom is loud, frequent snoring. But not everyone who snores has sleep apnea. Other symptoms of sleep apnea may include feeling irritable or depressed, or having mood swings. You may have memory problems or trouble concentrating. Or, you may wake up with a headache or a dry mouth.

Your doctor can diagnose sleep apnea based on your symptoms, a physical exam, and a sleep study. For a sleep study, your doctor may send you to a sleep lab or provide a portable sleep monitor. Sleep studies record things like heart rate and oxygen level while you sleep.



A sleep study can show whether apnea is mild or severe. "The largest proportion of the population with sleep apnea has mild sleep apnea," Twery explains. "Mild may or may not be associated with any daytime symptoms." People who are so sleepy that they're at risk of a drowsy driving accident are probably in the moderate to severe range.

Doctors may prescribe breathing devices that pump air or mouthpieces that adjust the lower jaw or hold the tongue. Other treatments are available and may be considered with advice from a physician familiar with your health.

Everyone deserves a good night's sleep. For self-care tips for breathing better while you're sleeping, see the "Wise Choices" box. If you feel extremely sleepy during the daytime or your bed partner says that you stop breathing when you're asleep, go talk with your doctor. ■



Wise Choices Breathe Easy!

Try these tips for improving your breathing when you're asleep:

- **Avoid alcohol before bedtime and don't take medicines that make you sleepy.** They make it harder for your throat to stay open when you're asleep.
- **Maintain a healthy weight.** Extra fat in the walls of your throat can make it narrower.
- **Sleep on your side instead of your back.** This helps keep your throat open.
- **Ask your physician about medicines.** Some medications can help open your nasal passages.



Web Links

For more about sleep apnea, click the "Links" tab at: newsinhealth.nih.gov/issue/Jul2017/Feature2

Health Capsules

For links to more information, see these stories online:
newsinhealth.nih.gov/issue/Jul2017/Capsule1

Why Do We Get Middle-Age Spread?

Did you know that the average young U.S. adult gains 30 pounds by the time they reach age 50? This weight gain happens even though most people tend to eat less over this time. Researchers have long known that losing weight and maintaining the ability to exercise tend to get harder beginning between ages 30 and 40—the start of mid-life. And working out pays off less than it used to.

NIH scientist Dr. Jay H. Chung and his colleagues think they've identified the biological changes that can explain this weight gain. In studies with lab animals, they found that an enzyme known as DNA-PK (DNA-dependent protein

kinase) slows down your metabolism, making fat harder to burn.

The team discovered that the muscles of mice and monkeys don't show much DNA-PK activity until middle age. At middle age, the enzyme's activity spiked.

Could blocking the elevated enzyme promote fat burning? To find out, the researchers used a drug that stops the enzyme from working. When fed a high-fat diet, obese mice receiving the drug didn't gain as much weight as other mice and were protected from type 2 diabetes. The drug also increased the fitness level of obese and middle-age mice.

"Our society attributes the weight gain and lack of exercise at mid-

life (approximately 30–60 years) primarily to poor lifestyle choices and lack of will power, but this study shows that there is a genetic program driven by an overactive enzyme that promotes weight gain and loss of exercise capacity at mid-life," Chung says.

These findings were only shown in animals. And this type of drug hasn't been tested in people. It might not work for people, or could have serious side effects. Until these questions are answered, there's no magic pill to ward away the spare tire associated with middle age. In the meantime, follow your doctor's suggestions for eating right, being active, and staying fit. ■

Explore Future Surgery Tools

Ever wonder what the future holds for health care technologies? Already, new tools are helping surgeons get a closer look inside your body. Robots enable operations that require only a small incision. Surgery is becoming less invasive, more effective, and safer. New materials equip surgeons with better ways to reconstruct tissues and promote faster healing.

Now you can explore the tools of the future with NIH's new interactive app. Float through a virtual 3-D operating room to learn about technologies including new imaging tools, robotics, biomaterials, and more. As you hover, click on objects to see the tools that are being developed right now.

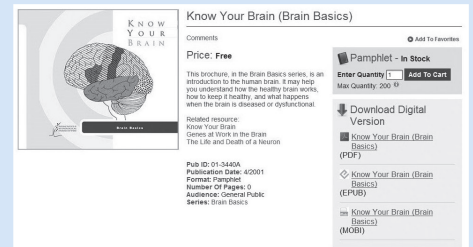
Watch a robot perform surgery. Robots can make stitches that are far tinier than a surgeon's. They can also bend and twist in ways that a surgeon's hand can't. Click on another tool to watch foam expanding inside a blood vessel to block an aneurysm, a balloon-like bulge in danger of bursting. There are many technologies to explore.

Download the app for free to your iOS or Android mobile device. Follow the links at <https://www.nibib.nih.gov/Surgery-of-Future>. Or search "Surgery of the Future" in the education category at the Apple App Store or "NIBIB Surgery of the Future" at the Google Play store. ■

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