INVENTED BY STUDENTS

BIOLGY: Health // CHEMISTRY: Mixtures and Solutions // PHYSICS: Nanotubes

JACK'S OPPONENT: A pancreatic cancer cell, seen through an electron microscope

MORTAL COMBAT
When a close friend died of pancreatic cancer two years ago, the loss hit Jack Andraka hard. Reading about the disease, the teen from Crownsville, Maryland, learned that this silent killer sneaks up on its victims, typically advancing undetected until it’s too late to treat. As many as 40,000 people die of the disease each year in the U.S. alone. Jack decided to do something about it.

At age 15, Jack created a cheap, fast, and accurate test that can detect pancreatic cancer when it’s just starting to develop. As part of a routine checkup, the test could save thousands of lives. Last year, Jack’s work earned him the top prize of $75,000 at the Intel International Science and Engineering Fair.

Jack’s mission to fight cancer started with a steep learning curve. “I didn’t even know what a pancreas was,” he says. He turned to Google and Wikipedia—and later, research papers—to get to know his enemy.

**PORTRAIT OF A KILLER**

Jack learned that the pancreas does double duty as a digestive and endocrine organ (see The Dual-Purpose Pancreas, p. 14). When a tumor grows there, it usually doesn’t cause symptoms at first. And the symptoms that eventually do show up—like back pain, nausea, and weight loss—are common ones with many possible causes.

Often, by the time the cancer is found, it has spread to other parts of the body.

Only 20 percent of patients live for more than a year after their doctors detect pancreatic cancer. “One of the greatest impacts on pancreatic cancer mortality is likely to come from improved early detection,” says cancer researcher Anirban Maitra of Johns Hopkins University in Baltimore, Maryland.

Part of the problem, Jack says, is that there’s no routine screening for the disease. There’s a blood test, but it catches only 70 percent of cases and can cost hundreds of dollars. And there’s a tumor-imaging scan, but it involves dyes that some people are allergic to. Plus, the scan exposes patients to radiation, which can damage cells that receive too much of it. So although the test is considered safe, doctors don’t use it without a good reason.

*Continued on the next page*
These tests are way too expensive and invasive to give to everyone. “I was sure there had to be a better way,” Jack says. He wanted a simple test that could catch the disease before it spreads.

FINDING THE KEY

Jack dug into scientific journals and stumbled across a database listing the levels of 8,000 different proteins in the blood of healthy people and those with various cancers. He went through the list one by one until he hit the jackpot: a protein called mesothelin. It’s present at low levels in healthy people but is off the charts in people with pancreatic, ovarian, or lung cancer.

The protein first skyrockets in the earliest stages of disease, long before symptoms appear—when surgical removal of the cancerous tumor can still save a person’s life. Jack realized that the protein could be a biomarker, or distinctive indicator, for those three cancers. Doctors could test a patient’s blood sample, and if the mesothelin level is high, the person probably has cancer.

The next challenge was to figure out how to detect the biomarker protein in blood cheaply and quickly. The solution came to Jack one day in his ninth-grade biology class. His teacher was giving a lesson on antibodies. An antibody protein helps fight infections by binding to a particular molecule that fits it perfectly, like a lock and key.

Jack realized that antibodies could be the ideal way to detect mesothelin. An antibody that binds only to mesothelin could reveal how much of the protein is present in a blood sample—which means a doctor could tell whether someone may have cancer.

PERSISTENCE PAYS OFF

Once Jack had the idea of using antibodies to detect cancer, he needed to get into a lab to test it.

He contacted 200 different researchers to ask them if he could work in their laboratories. Only one, Maitra, sent an encouraging reply. Maitra invited Jack to Johns Hopkins for an interview. For an hour, he grilled Jack about his plan. Finally, Maitra agreed to give him a chance.
Through months of painstaking work, Jack tested many antibodies to determine which bound most strongly and specifically to mesothelin. Then he coated small strips of paper with the antibody.

To see how reliable the strips were at detecting mesothelin, Jack mixed up solutions with different concentrations of the biomarker and dipped the strips into them. The strips performed flawlessly: They could accurately measure different amounts of mesothelin—which meant they could detect pancreatic cancer in time to save lives (see How Jack’s Test Works, below).

“When I got those first results, I ran around the lab screaming,” he says. “Luckily it was late at night, and there was no one there to see me.”

PUT TO THE TEST

The next big hurdle was to test Jack’s strips on actual blood samples, first from mice and then from people. The strips came through with flying colors. Time after time, they accurately distinguished cancerous blood samples from healthy ones.

Each test strip costs just three cents to make and gives results in five minutes. Jack has applied for a patent on the test, and he hopes that after a few more years of research, it’ll be available at routine health exams.

Now 16, Jack can hardly wait until his test can start helping to save lives. “Anyone can do science,” he says. “All you need is an idea and a passion.”

—Jennifer Barone

HOW JACK’S TEST WORKS

A drop of blood is all it takes to run this amazingly accurate cancer screening.

1. The cancer test consists of a strip of paper coated in antibodies and carbon nanotubes, microscopic tubes made of carbon atoms that can conduct electricity.

2. When the paper strip is dipped in a blood sample, the antibodies bind to the protein mesothelin in the blood. Certain cancers increase levels of this protein.

3. The binding reaction causes the nanotubes to shift, which changes their electrical properties. Measuring that change reveals whether mesothelin levels are high—meaning cancer is present—or low.


CORE QUESTION

What are three advantages of Jack Andraka’s test for pancreatic cancer, compared with existing tests?