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A Pandemic Upon Us

Researchers battle avian flu threats to poultry industry and humans.

BY JANE M. SANDERS

@ Avian influenza threatens to devastate the poultry industry and infect humans. A comprehensive new study is targeting the disease, including its early detection with a biosensor developed at the Georgia Tech Research Institute.

ABOVE: This is a colorized transmission electron micrograph of avian influenza (H5N1 strain) viruses (seen in gold). Avian influenza viruses do not usually infect humans, but several instances of human infections and outbreaks have been reported since 1997.

With potentially devastating losses to the economy and new threats to human lives, avian influenza is the focus of research worldwide on ways to detect and control the disease.

In the United States, outbreaks of the disease — primarily spread by migratory aquatic birds — have plagued the poultry industry for decades with hundreds of millions of dollars in losses. The only way to stop the spread of the disease is to destroy millions of poultry farm birds that may have been exposed to the virus.

Recently, a virulent strain of avian influenza (H5N1) has begun to threaten not only birds but humans — this time in Asia. The continent has experienced widespread outbreaks in the poultry industry and some cases in humans, many of which were fatal. Looming is the threat of a pandemic — such as the 1918 Spanish flu that killed about 40 million people — health officials say.

Early this year, in response to the threats, the U.S. Department of Agriculture's Cooperative State Research Education and Extension Service awarded its largest grant ever to study a single animal disease or health threat. That $5 million, multi-institutional study — headquartered at the University of Maryland (see www.agnr.umd.edu/aicap/aicp4/AICAP4/) — is funding biosensor research at the Georgia Tech Research Institute (GTRI), joined by a grant from the Georgia Research Alliance. Researchers are determining the feasibility of using GTRI's optical waveguide sensor — which can detect a variety of environmental, foodborne and terrorism-related agents — to find the disease on farms before it spreads.

"Quicker detection is the key so infected flocks can be isolated and destroyed," says J. Craig Wyvill, head of the GTRI Food Processing Technology Division. "If our low-cost, rapid-screening biosensor was used by the industry, it could help cut hours off the time it takes to get test results, thereby giving the industry a huge jump on controlling the spread of this disease. Our integrated-optics sensing platform is ideal for field application."

The sensor consists of a laser light source, a planar waveguide (essentially a small piece of glass through which the light travels) and a detector for monitoring light output. Chemical reactions — in this case, the binding of an avian influenza antibody to the virus that causes the disease — on the waveguide surface alter the speed of light through the waveguide. This change is monitored with an interferometer by comparing a reference beam with another beam traveling under the sensing chemistry. Signal processing software interprets the sensor's results and delivers information on

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Avian influenza has been a major problem in the U.S. poultry industry since the 1960s. It is primarily spread by infected migratory aquatic birds — which rarely fall ill from the virus — that leave droppings around poultry farms. The feces can enter chicken houses on the shoes of workers, or be blown in by wind after it dries.

– GTRI and USDA researchers

PHOTO BY HALLGRIMUR ARNARSON, COURTESY ISTOCKPHOTO.COM

PHOTO BY GARY MEEK

LEFT: GTRI researchers led by senior research scientist David Gottfried are determining the feasibility of using their optical waveguide sensor — which can detect a variety of environmental, foodborne and terrorism-related agents — to find the avian influenza on poultry farms before it spreads.

the agents' identity and quantity. The waveguide chip is small enough that it can accommodate several sensing channels designed to detect multiple agents.

With the new funding, GTRI researchers will search for the best-suited avian influenza antibodies to serve as the sensor's receptor for binding the avian influenza virus to the sensor surface, explains lead researcher and GTRI senior research scientist David Gottfried.

In contrast to most antibody assays that contain multiple chemical binding steps, the GTRI sensor is a direct assay — meaning it directly detects the antibody binding to the target virus.

"The question we're trying to answer is whether these avian influenza antibodies will work in a direct assay," Gottfried says. "With any new target, there are always the initial steps to evaluate whether these antibodies are valuable as capture antibodies and will give you the sensitivity and selectivity by themselves without additional reaction steps."

Gottfried and his colleagues will take multiple approaches in determining the best antibodies to use in the sensor. "We can look for the entire virus or break the virus apart and look at its interior," he explains. "There are a number of antigens associated with this virus that we can look at…. With this sensor, we can detect four to eight agents in one sample."

The initial research will use a less harmful H7 strain of the virus as a model for sensing avian influenza, Gottfried notes. "Ultimately, we'll extend our work to other more relevant strains," he adds.

There are two questions to answer in this first year of study, researchers note. Will this sensing technology work for this application and if so, how well? Also, Gottfried adds, "We're determining whether our sensing technology is competitive with other approaches in terms of cost, time, sensitivity and ease of use."

Though researchers expect this grant to cover development of a prototype device for further lab and field testing, the system design of a com-

BELOW: J. Craig Wyvill is head of the Georgia Tech Research Institute Food Processing Technology Division.

In the 20th century, humans experienced three major influenza A pandemics. The most devastating was the 1918 "Spanish flu" that killed between 20 and 40 million people — more than 600,000 of whom were in the United States

— U.S. Department of Agriculture

PHOTO COURTESY GTRI

> "In an avian influenza outbreak, time is valuable. Anything that can push the recognition point up has huge value."
>
> J. Craig Wyvill, division chief, GTRI Food Processing Technology Division

mercial sensing device would come later with additional funding.

"The bottom line is that we'll be looking for simplicity in this application," Wyvill says. "Will this sensor work easily in the field for detecting avian influenza?"

Most biosensors now offered commercially work only in a laboratory setting, and there is typically a 24-hour delay in getting test results. "In an avian influenza outbreak, time is valuable," Wyvill notes. "Anything that can push the recognition point up has huge value. Our sensor is one of the few that offers portability and low cost. These aspects make it very promising."

The sensing device would probably cost around $1,000, not including the costs for assay chips and antibodies, the researchers estimate. The whole package might be manufactured and marketed by pharmaceutical companies, Wyvill says. Typical users would likely be poultry farm service representatives and perhaps veterinarians, as well as government inspectors, he adds.

Field-based detection of avian influenza will likely follow faster laboratory diagnostic tests being developed by David Suarez at the USDA's Southeast Poultry Research Laboratory, which is providing antibodies and test samples for GTRI's research. For now, no field screening is occurring in the United States, and lab tests take at least four hours to complete.

"We want to be able to spot it in the field, isolate it and end it rather than dealing with the current time delays involved with sampling and lab tests," Wyvill says. "With rapid field testing, we could isolate the disease and keep it from spreading to neighboring farms."

@ Read more at: **gtresearchnews.gatech.edu/reshor/rh-ss05/avianflu.html**

PHOTO COURTESY GTRI

According to the U.S. Department of Agriculture, uncontrolled avian influenza in the United States could paralyze the industry and compromise the nation's position as the leading exporter of poultry in the world.

BELOW: USDA veterinary medical officers evaluate tissue sections from chickens infected with Hong Kong H5N1 influenza. The monitor displays a photo of chicken legs showing physical damage resulting from the flu virus.

PHOTO BY ROB FLYNN, USDA AGRICULTURAL RESEARCH SERVICE

Industry Synergy

New Georgia Tech Food Processing Technology Building enhances collaboration.

BY JANE M. SANDERS

Researchers and industry leaders working to make food processing safer and more efficient got a boost recently with the opening of a new building designed for collaborative technology development at the Georgia Institute of Technology.

Eight years in the making, the 36,000-square-foot first phase of Georgia Tech's $9.4 million Food Processing Technology Building opened its doors on March 1. Georgia Governor Sonny Perdue and other officials dedicated the new facility — built with public and private funds — in an official opening ceremony on May 19.

The facility houses offices and research laboratories for automation, information, and environmental technology development, a 4,300-square-foot, high-bay prototyping area, a 48-seat auditorium and a large conference room for industrial and organizational meetings and events. Also, an interactive lower lobby exhibit area is being designed to entertain and inform visiting K-12 student groups and others about the growing role technology is

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The USDA's Southeast Poultry Research Laboratory (SEPRL) in Athens, Ga., conducts extensive research on avian influenza and is collaborating with the Georgia Tech Research Institute on its development of an interferometric optical waveguide sensor to detect the disease in poultry. For more information on SEPRL research, see seprl.ars.usda.gov/default.htm.

playing in food and poultry processing operations.

The new building serves as headquarters for the Food Processing Technology Division of the Georgia Tech Research Institute (GTRI), the non-profit applied research arm of Georgia Tech. Through the division, GTRI conducts significant industrial research under two major programs: the Agricultural Technology Research Program (ATRP) and Georgia's Traditional Industries Program for Food Processing, which is managed through the Food Processing Advisory Council (FoodPAC).

Ranked as one of the top programs of its kind in the country, ATRP works closely with Georgia agribusiness, especially the poultry industry, to develop new technologies and adapt existing ones for specialized industrial needs. Researchers focus efforts on both immediate and long-term industrial needs, ranging from advanced robotic systems to improved wastewater treatment technologies to machine-vision grading and rapid microbial detection. FoodPAC is committed to enhancing the competitiveness of Georgia's food industry, and through the Traditional Industries Program, has helped GTRI to commercialize some of its developments while also adapting them to the needs of such industries as bakeries and fruit processors.

"The completion of the Food Processing Technology Building marks the start of a new era for Georgia Tech's food processing research activities," says J. Craig Wyvill, division chief. "The facility, with its many state-of-the-art laboratories, small prototype fabrication shop, and high-bay test and construction area, provides an environment that will help facilitate collaborative food processing technology development."

Food and poultry companies, as well as equipment and supply companies, will be able to collaborate with researchers in the early stages of new technology development without placing undue pressure on either party to deliver or purchase a commercial system, Wyvill explains. This type of collaboration gives both sides an opportunity to jointly assess the potential of an emerging or new technology away from the stress of having to make a buying or selling decision. The building's high-bay prototyping area provides new space to set up test cells to evaluate and enhance new products unproven in commercial plant settings.

"We want this facility to be a focal point also for joint university collaboration and for collaboration with technology companies that do not have an existing focus on the food industry," Wyvill adds.

A Phase II addition to the building will add 10,000 square feet for offices and laboratories for human factors, food safety and bioprocessing research. A campaign is under way to raise the $2.1 million needed for this addition.

Fundraising for the $7.3 million Phase I building was coordinated through FoodPAC and the Georgia Poultry Federation. State bonds provided $4.73 million with the balance provided by private sources that included pledges and donations from 17 companies — all with facilities in Georgia — that manufacture food products or offer equipment and technological support to the industry.

They are: Air Products and Chemicals; American Proteins; Cagle's; Claxton Poultry Farms; ConAgra Foods; Crider Poultry.; Cryovac-Sealed Air Corporation; FMC Technologies; Gold Kist; Mar-Jac Poultry; Meyn Poultry Processing; Seaboard Farms (now part of Pilgrim's Pride); Stork Gamco; The BOC Group; Thinkage; Tyson Foods; and Wayne Farms.

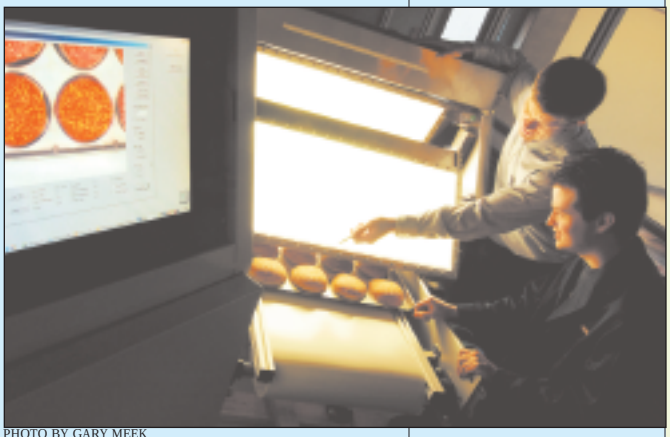

PHOTO BY GARY MEEK

@ Read more at: **gtresearchnews.gatech.edu/newsrelease/food-processing.htm**

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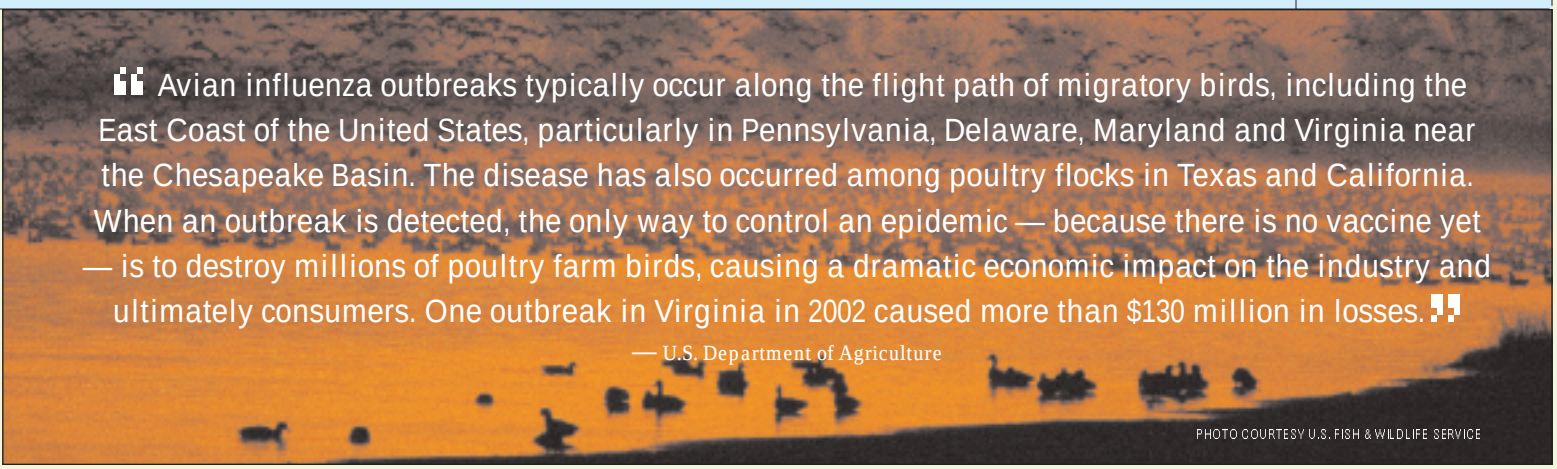
BELOW: Project director Doug Britton, left, and undergraduate student Erik Kline demonstrate a prototype baked-goods imaging system to inspect for color, shape and seed coverage of sandwich rolls in high-volume bakeries.



"Avian influenza outbreaks typically occur along the flight path of migratory birds, including the East Coast of the United States, particularly in Pennsylvania, Delaware, Maryland and Virginia near the Chesapeake Basin. The disease has also occurred among poultry flocks in Texas and California. When an outbreak is detected, the only way to control an epidemic — because there is no vaccine yet — is to destroy millions of poultry farm birds, causing a dramatic economic impact on the industry and ultimately consumers. One outbreak in Virginia in 2002 caused more than $130 million in losses."

— U.S. Department of Agriculture

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