Nano-devices hold promise for early-stage cancer detection

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They are miniature labs that can be swallowed like a pill, injected through a catheter, or woven into fabric. Their function is to screen for, detect, and potentially treat, cancer and other diseases when they are still at a single-cell size in early development stages. They will also detect harmful pathogens in food and water.

Engineering researchers at McMaster University will be escalating efforts to develop these micro- and nanotechnology-based bio-sensors and imaging devices through the support of a recently announced $4.25 million grant from the Canada Foundation for Innovation (CFI).

"This research is opening up a new front in the battle against cancer and other diseases," said Jamal Deen, the lead applicant, professor of electrical and computer engineering and Canada Research Chair in Information Technology, McMaster University. "The technology zeros in on specific malignant cells at an early stage when treatment can be more effective and potential side effects minimized."

The funding is part of a $10.6 million initiative to expand existing nano-fabrication and integration facilities at McMaster to establish a world-class Micro- and Nano-Systems Laboratory for the development of miniaturized, low-cost and easy-to-use prototypes for imaging and sensing in healthcare and environmental applications.

"The imaging and sensing technologies being pursued would be non-invasive, removing the discomfort, expense, and risk associated with

many screening procedures, such as a colonoscopy," said Qiyin Fang, assistant professor of engineering physics and Canada Research Chair in Biophotonics at McMaster. "It would therefore allow for large-scale screening for early disease detection."

The bio-sensors and imaging devices being explored are based on integrating dissimilar technologies such as DNA, semiconductors, nanowires and polymers into "smart systems" on a small chip. The resulting micro-labs could contain miniaturized systems for fluid filtration, DNA extraction, cell processing, imaging, computing, wireless communications, and laser and radiation detection systems.

Research currently underway includes:
-- a miniature (pill-sized) device that will provide early detection of abnormal cells inside the body;
-- an imaging and communication system for non-invasive screening in target organs systems such as the breast, pancreas and gastrointestinal tract and the relaying of information to an external receiver;
-- developing ingestible and insertable non-invasive imagers for routine screening of pancreatic and gastrointestinal tumors;
-- sensors that can detect food- and water-borne pathogens.

"The ultimate goal is to develop reliable and inexpensive detection and imaging products that can be used in a doctor’s office or possibly even at home as part of a regular exam," said Steve Hranilovic, assistant professor of electrical and computer engineering at McMaster. "This would address wait-time and cost issues associated with MRI, CT and other imaging facilities. It would also reduce the misdiagnosis and uncertainty associated with self-examinations."

Research has shown that early detection of cancer improves cure and survival rates dramatically. For example, the five-year survival rate of breast cancer patients when a tumor is detected at less than two

centimeters in size is 98 per cent. It is only 26 per cent when the tumor is larger than five centimeters. For colorectal cancer, the second leading cause of cancer death, at least 90 per cent of cases can be cured with proper screening and surveillance.

Engineering faculty at McMaster are working closely with their colleagues in health sciences on this research, as well as with researchers at the Universities of Toronto, Waterloo, and Calgary, McGill University and the National Research Council.

"This initiative is possible because engineers are collaborating closely with medical practitioners and scientists to develop real solutions," said Mo Elbestawi, Dean of Engineering, McMaster University "The lab will attract exceptional researchers and students, and foster innovative and high-profile interdisciplinary research. It will create novel and exciting learning environments for training, and attract new industrial partnerships."

Plans call for the lab to occupy approximately 9,600 square feet and include a clean room, bonding and packaging facilities, characterization facilities, and prototyping and testing.

"The development of this unique infrastructure complements research already underway at McMaster in the related fields of biomedical engineering, manufacturing and materials, information technology, and nanotechnology," said Elbestawi. "Funding support from government is seeding a nanotechnology cluster in Canada that can compete internationally."

Source: McMaster University