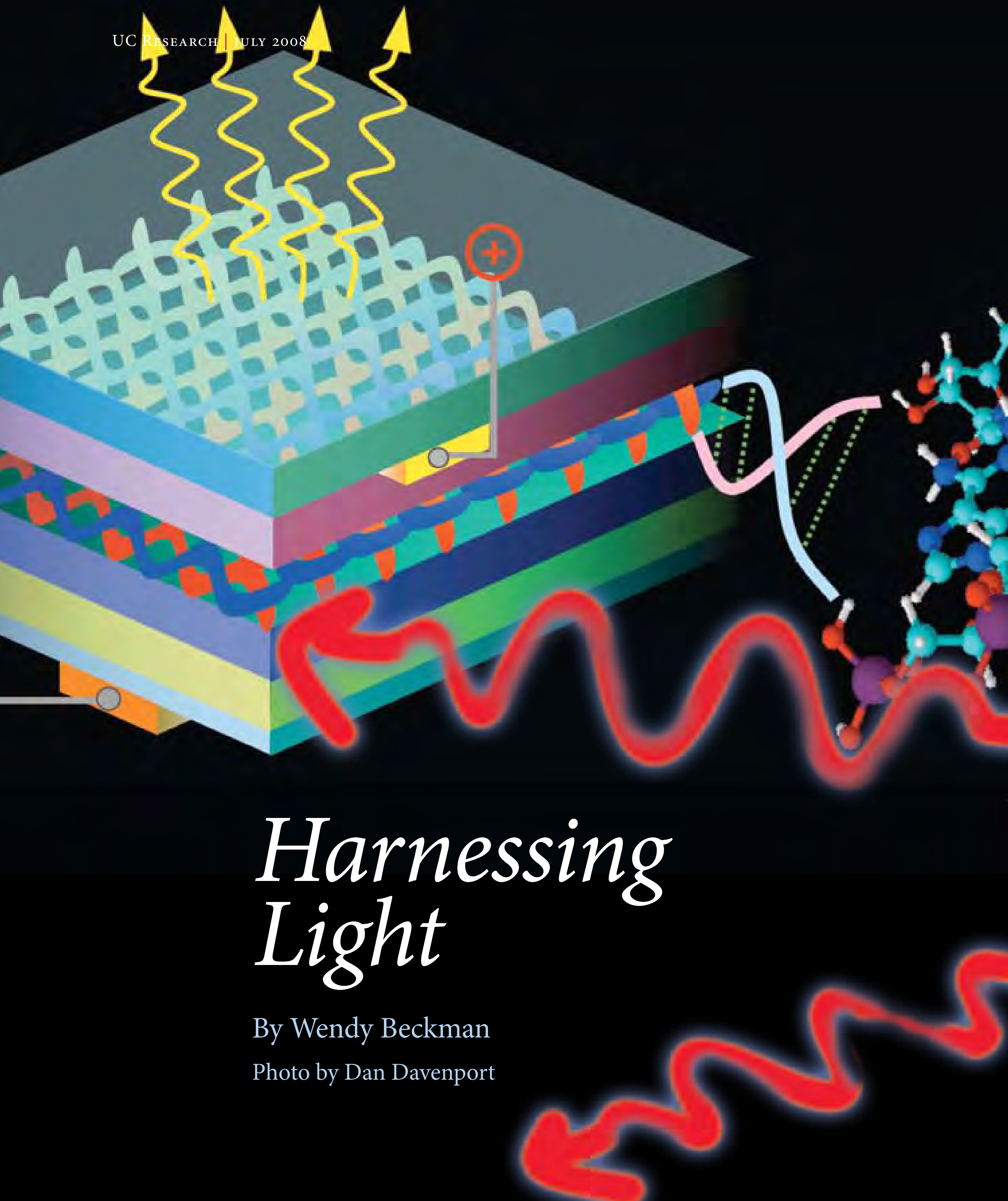
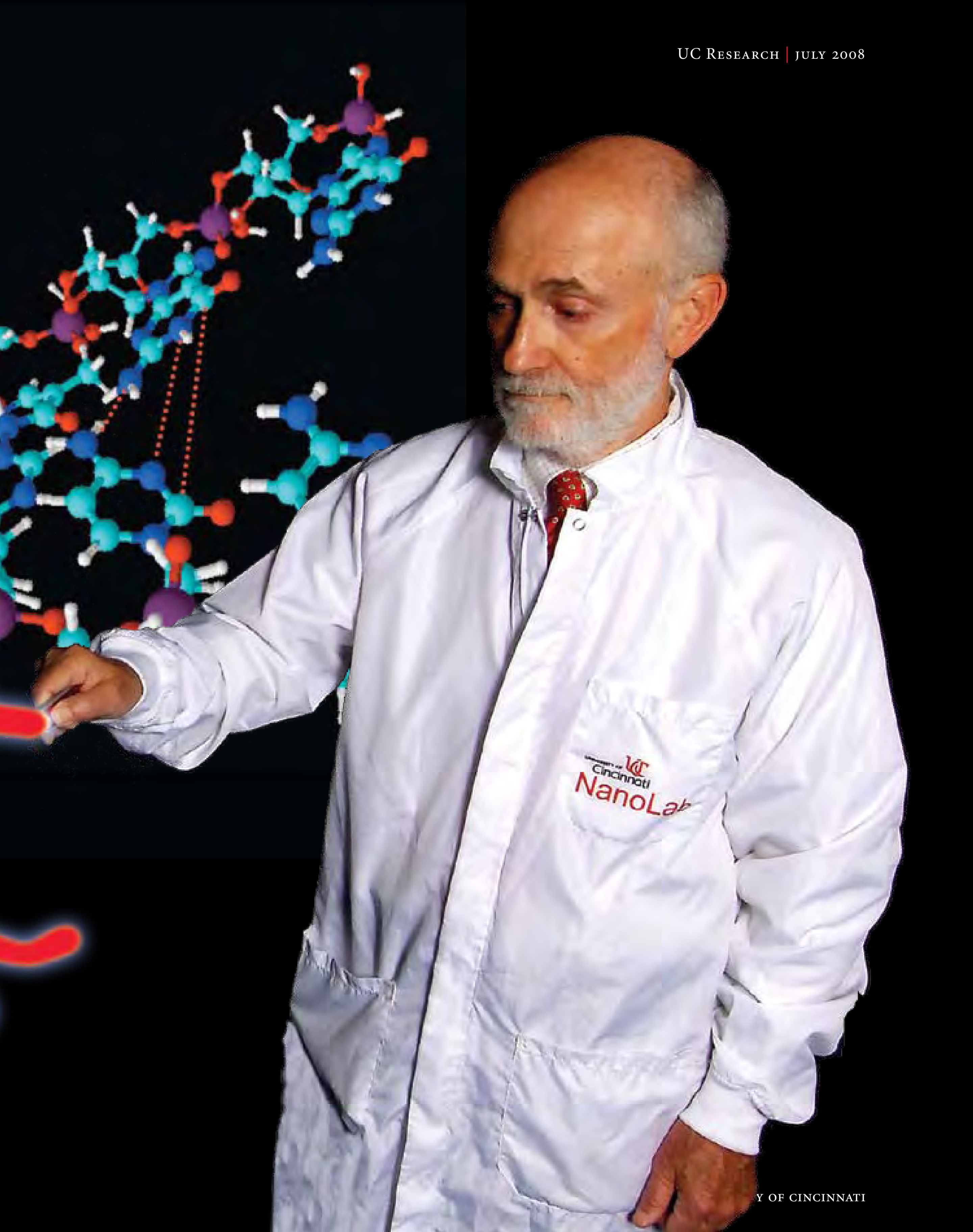


Harnessing Light

By Wendy Beckman

Photo by Dan Davenport


Cincinnati
NanoLab

Light. It's the topic of Andrew Steckl's research, but it's also what his face is full of as he describes it.

Spend an hour with him and you walk away thinking that photonics—the study of light—makes complete sense. That you actually understand it.

Steckl has a knack for taking complex research subjects and breaking them down into easily understood packets of information.

"Basically when light is emitted, you understand intuitively what's going on," Steckl says. "The color of the light, the intensity of the light, what you can do with the light—it's a lot of fun to work with."

And work with it he has.

The Ohio Eminent Scholar and UC professor of electrical engineering has built his career on harnessing light to create or improve electrical devices. His research could lead anywhere from improved testing and therapeutic devices in the health care setting to better, brighter displays.

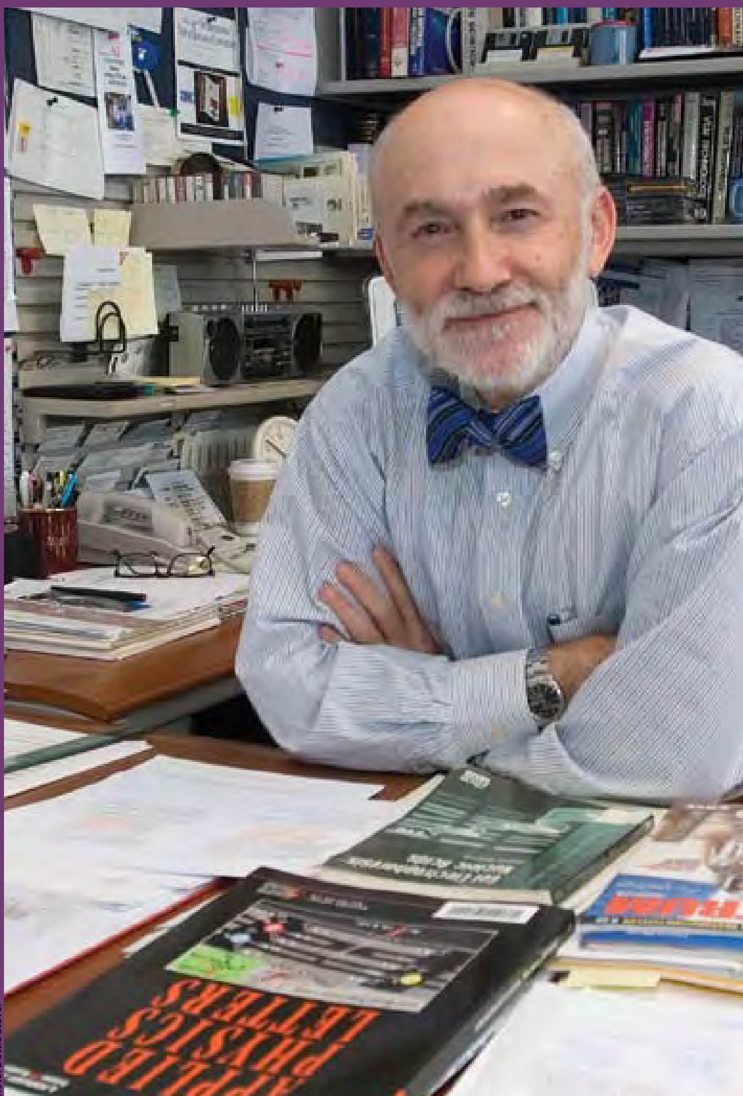


Photo: Dottie Stover

trapped

Incorporating DNA thin films as electron-blocking layers allows improvements of one to two orders of magnitude in terms of efficiency and light brightness.

One finding in particular has garnered Steckl international attention. He discovered that DNA from salmon sperm enhances the brightness of light emitting diodes (LEDs), commonly used in television and cell phone displays.

In a study funded by the U.S. Air Force, UC's photonics expert discovered that by adding a film of the biological material he could influence the movement of electrons and manipulate the amount of light emitted.

Electrons move constantly. When they collide with oppositely charged particles, they produce very tiny packets of light called "photons."

"Some of the electrons rushing by [one another] have a chance to say 'hello,' and get that photon out before they pass out," Steckl explains. "The more electrons we can keep around, the more photons we can generate.

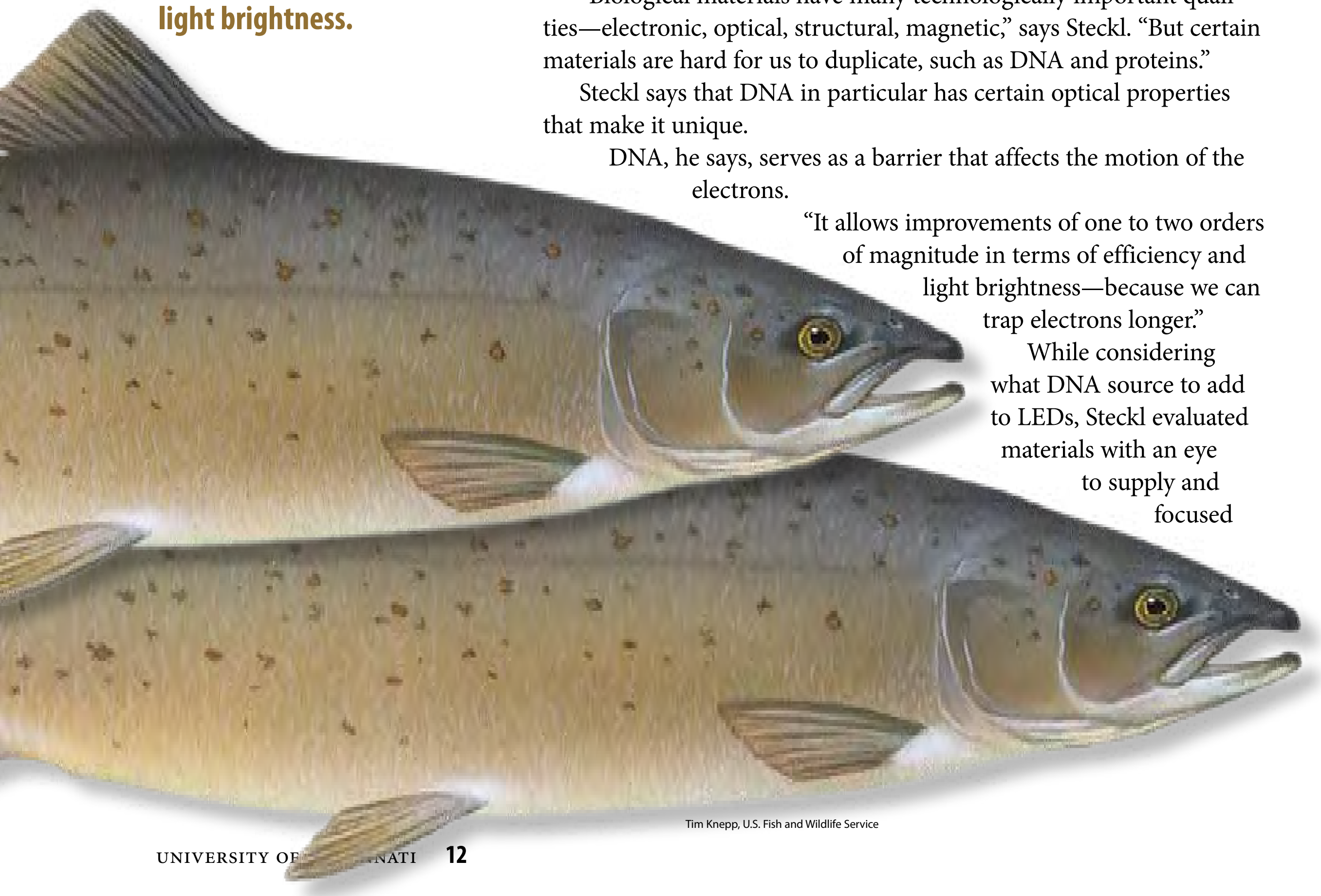
"Biological materials have many technologically important qualities—electronic, optical, structural, magnetic," says Steckl. "But certain materials are hard for us to duplicate, such as DNA and proteins."

Steckl says that DNA in particular has certain optical properties that make it unique.

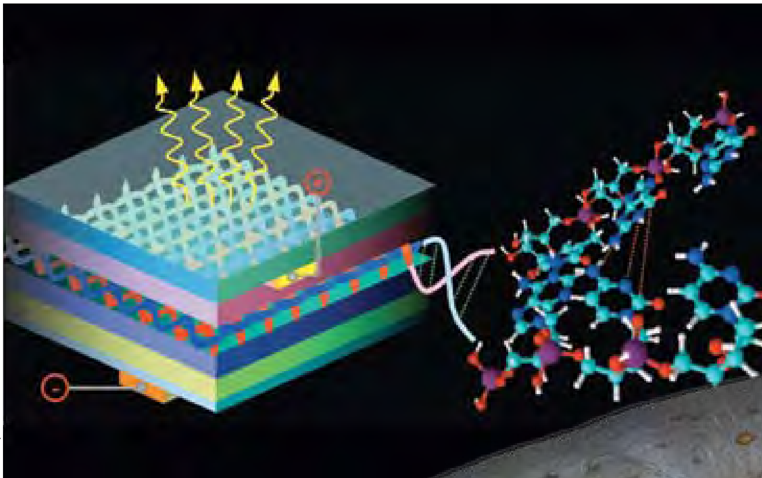
DNA, he says, serves as a barrier that affects the motion of the electrons.

"It allows improvements of one to two orders of magnitude in terms of efficiency and light brightness—because we can trap electrons longer."

While considering what DNA source to add to LEDs, Steckl evaluated materials with an eye to supply and focused



Tim Knepp, U.S. Fish and Wildlife Service



Courtesy: Andrew Steckl

Tim Knepp, U.S. Fish and Wildlife Service

on finding something that would not harm the environment.

He wanted something that was widely available. An item that would not have to be mined and was not subject to any organization or country's monopoly.

The answer was salmon sperm.

"Salmon sperm is considered a waste product of the fishing industry. It's thrown away by the ton," says Steckl with a smile. "It's natural, renewable and perfectly biodegradable."

So began Steckl's work with BioLEDs, LED devices that incorporate DNA thin films as electron-blocking layers. Most of the devices existing today are based on inorganic materials, such as silicon. In the last decade, researchers have been exploring using organic materials in devices like diodes and transistors.

"The driving force, of course, is cost: cost to the producer, cost to the consumer and cost to the environment," Steckl points out, "but performance has to follow."

The next step is to now replace some other materials that go into an LED with organic biomaterials. The long-term goal is to be able to make "green" devices that use only natural, renewable and biodegradable materials.

And he points out that for the United States, the green device approach takes advantage of something in which we still continue to be a world leader—agriculture.

Steckl's work with salmon sperm began several years ago, but, he says, "The story continues. I'm receiving salmon sperm from researchers around the world wanting to see if their sperm is good enough."

The long-term goal is to be able to make "green" devices that use only natural, renewable and biodegradable materials.

liquid logic

Steckl has designed and fabricated a device that operates in the liquid state and can directly convert charge-related information from the fluid into electronic, measurable signals.

Steckl not only puts biological materials into electronic devices, he also enmeshes devices with biological materials.

Tiny light-emitting materials called lumophores can be attached to other objects, including biological molecules, and then be used to indicate the presence of certain substances.

This small-scale research promises big improvements in such things as "lab-on-a-chip" devices.

These miniscule gadgets, reminiscent of the 1966 movie "Fantastic Voyage," can be introduced into the bloodstream to monitor the blood's chemistry. Steckl calls this "liquid logic"—using liquids, not solids, to make electronic devices.

"Biomedical applications are a natural," Steckl continues. "Biomedical devices are both analytical in the way they take measurements and therapeutic—delivering treatment."

One of the problems with traditional health-monitoring devices is that the information contained in the liquid (blood, for example) must be translated into electrical signals that can be read in some kind of measuring instrument. Classic methods for this "translation" have been based on light and colorimetric measurement, direct optical sensing (using a video camera or detector) or combinations of optical excitation of fluorescent dyes.

Steckl has designed and fabricated a "lab-on-a-chip" device that operates in the liquid state and can directly convert charge-related information from the fluid into electronic, measurable signals. Such a device could co-exist in the human body, for example, which is mostly liquid. This technology could have applications in biology, health sciences and many other areas.

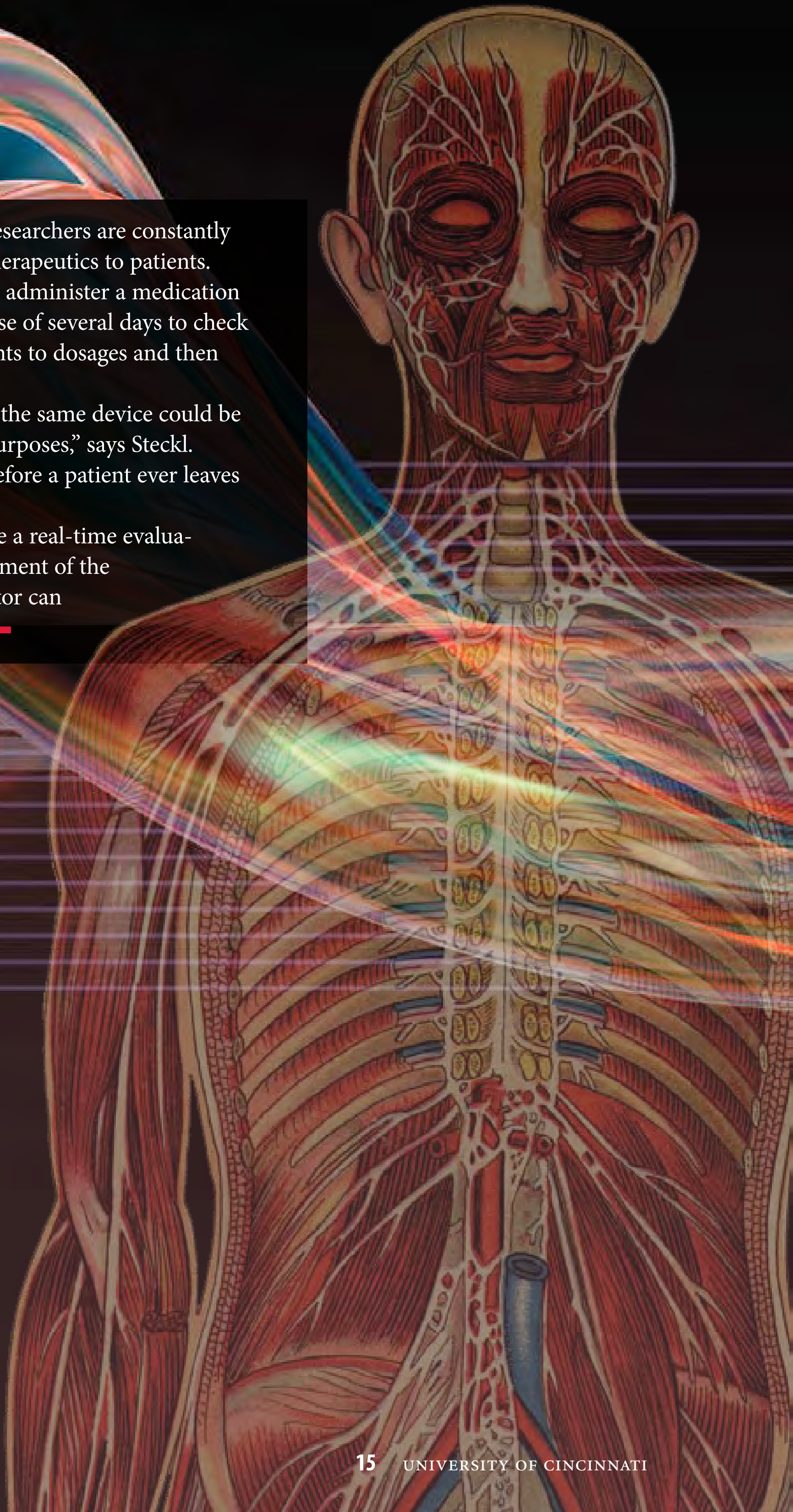
Drug delivery is a prime example, as researchers are constantly looking for ways to optimize delivery of therapeutics to patients.

In a health care setting, a doctor might administer a medication and then use several devices over the course of several days to check the condition of a patient, make adjustments to dosages and then monitor the patient's reaction.

"More research is needed, but perhaps the same device could be used for both analytical and therapeutic purposes," says Steckl.

And it could all be done in real time before a patient ever leaves the office.

"With a device like this, you could have a real-time evaluation of effectiveness and a real-time adjustment of the dose," says Steckl. "The faster that the doctor can know the effects of the drug, the better."



Receiving measurements from inside the bloodstream may not be so 'fanastic' after all.