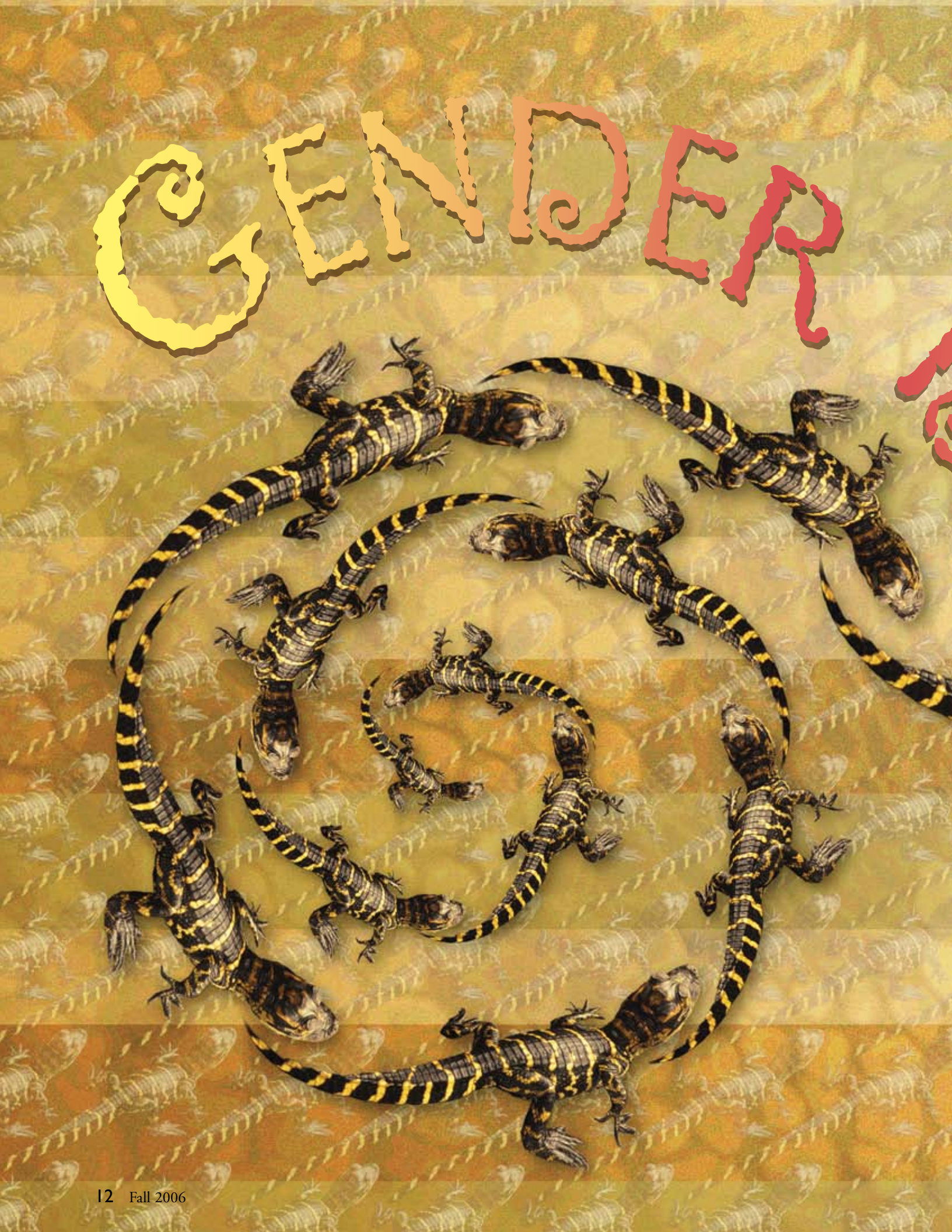
GENDER



Zoologist Lou Guillette has spent his career tracking the effects of pollution on alligator reproduction and sharing his passion with students

SPENDER

BY CATHY KEEN

For most people, the business end of an alligator is the one with the big teeth in an even bigger mouth.

But for UF zoologist Lou Guillette, the size of an alligator's penis is more important than the size of its teeth. Over the last two decades, Guillette and his colleagues have tracked how environmental contaminants impact reproduction in Florida's alligators.

And while talking about alligator penises may generate more than a few chuckles, to Guillette it's no laughing matter.

"This always spurs a lot of giggles when people first hear about it, but what is not funny is that in the United States and many developing countries there has been a dramatic increase over the last 25 or 30 years in penile abnormalities in baby boys," he says.

He was not exaggerating when he once told a Congressional committee, "Each man in this room is half the man his grandfather was," considering that sperm counts in some populations of modern males are 50 percent lower than they were two generations ago.

But for Guillette, "The major question is not whether this happened 50 years ago, or what's happened to us and our generation, but what is going to happen to future generations."

Guillette's revelations about alligator reproduction have contributed to the passage in 1996 of the Food Quality Protection Act, described by the Environmental Protection Agency as "the most comprehensive and historic overhaul of the nation's pesticide and food safety laws in decades," and a United Nations treaty limiting the use of pesticides.

Guillette's influence, however, may endure more in the hundreds of undergraduate and graduate students he has mentored over the years. In recognition of both his scientific and teaching prowess, earlier this year Guillette was named one of just 20 Howard Hughes Medical Institute professors nationwide. The professorship comes with a $1 million, four-year grant that Guillette is using to develop a unique mentoring program.

"Science is the four best jobs on Earth," Guillette says. "It's being a detective in trying to figure out whodunit. We're artists in creating and breaking new ground. It's adventure, whether it's being out on an airboat at night hunting alligators, discovering a new gene or looking through a microscope and seeing something no one has found before. And finally, it's storytelling, because if I discover something and never share it, no one will ever know."

Lizards Small & Big

As an undergraduate student at New Mexico Highlands University, Guillette had an "incredible mentor" in microbiology Professor John Spencer, who gave him unlimited access to his laboratory. It was the 1970s and Guillette's interest in science blossomed alongside a growing national consciousness. Rachel Carson's 1962 manifesto *Silent Spring* focused attention on environmental contaminants, concerns about human use of natural resources led to the first observance of Earth Day, the term "population bomb" entered the lexicon and environmental science classes emerged on college campuses.

While Spencer was doing some "cool research" in hot springs bacteria, Guillette found himself increasingly drawn to reproductive biology.

"I was in my junior or senior year when I realized that reproductive biology was the center of biology," he says. "Those individuals or species that reproduced went on to the next generation. Those that didn't went extinct."

Studying a lizard for his dissertation at the University of Colorado, Guillette pioneered techniques for documenting the evolutionary steps from egg bearing to live bearing.

He came to UF in 1985 as an assistant professor, planning to expand his scope of studies to pregnancy and development of the placenta.

But shortly after he arrived in Gainesville, he received a visit from ecologists with the U.S. Fish and Wildlife Service and the Florida Game and Freshwater Fish Commission. To help the state's alligator farmers maintain healthy populations, they needed someone to study the reproductive biology of the most famous "lizard" in Florida's lakes.

"I told them I knew nothing about alligators, that I had only worked on lizards in the mountains," Guillette recalls.

Reservations about his qualifications notwithstanding, Guillette was soon navigating an airboat through the murky waters of Lake Apopka near Orlando.

Lou Guillette steers an airboat on Orange Lake, south of Gainesville, in late September.

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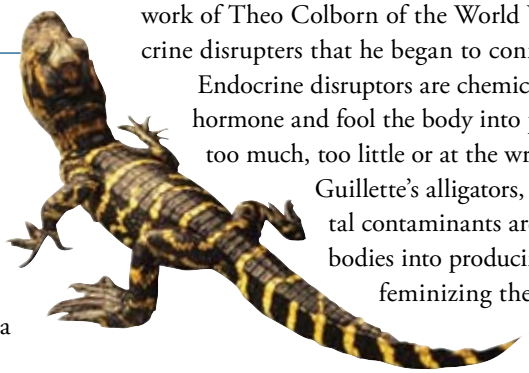
Piercing the night darkness with a powerful flashlight, he mentally measured the distance between an alligator's red reflecting eyes to gauge its size before he and colleague Allan Woodward of the Florida Fish and Wildlife Conservation Commission snared it with a rope and wrestled it into the boat. After a gentle poke for a blood sample, it was set free with the flick of a muscular tail and a resounding splash.



As they crunched the data, a picture began to emerge of reproductive abnormalities, including elevated hormone levels and abnormal reproductive organs, including smaller penises.

Lake Apopka had been the site of a major pesticide spill in 1980, in addition to being the final destination of pollutants from agriculture, storm water and septic tank leaks over the years.

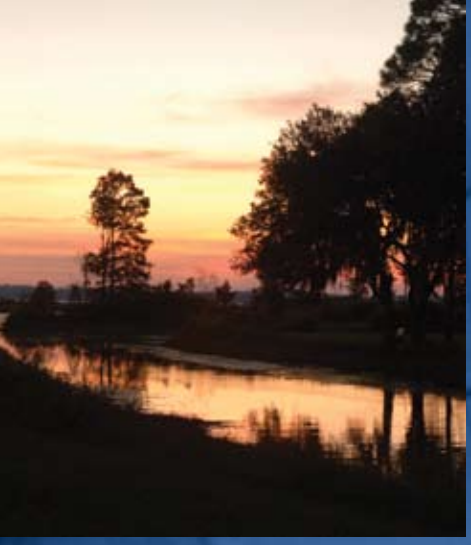
But it wasn't until Guillette heard about the pioneering work of Theo Colborn of the World Wildlife Fund on endocrine disrupters that he began to connect the dots.

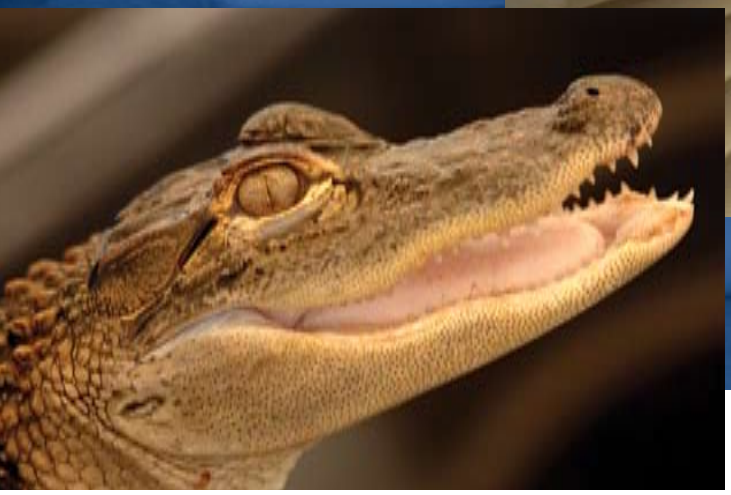
Endocrine disruptors are chemicals that mimic a natural hormone and fool the body into performing a function too much, too little or at the wrong time. In the case of Guillette's alligators, it appears environmental contaminants are fooling the creatures' bodies into producing too little testosterone, feminizing the males.

Photography by Kristen Bartlett

Zoology doctoral student Lori Albergotti, right, and postdoctoral researcher Satomi Kohno keep a close lookout for more baby alligators.

(From top) Chenan Zhang, a biochemistry undergraduate, grabs a baby alligator from the lake. After drawing some blood, Zhang and doctoral student Ashley Boggs record tag numbers and other data as Guillette draws blood from the next alligator.





Guillette, Chenan Zhang and Ashley Boggs use a GPS device to mark the exact position on Orange Lake where an alligator was captured.

In the case of Guillette's alligators, it appears environmental contaminants are fooling the creatures' bodies into producing too little testosterone, feminizing the males.

As Guillette told PBS *Frontline* in 1997, "It was one of these incredible experiences when you realize, I have hormonal abnormalities. I have a contaminated lake. I have a top predator that accumulates contaminants. It all just kind of came together as a hypothesis."

Eventually, he and his colleagues found the same kinds of reproductive abnormalities in Lake Griffin, Lake Okeechobee and other central Florida lakes.

In addition to the field work, Guillette, Professor Taisen Iguchi of Japan's National Institute of Basic Biology and zoology Assistant Professor Ed Braun set about sequencing hundreds of alligator genes for the first time.

"When we started, almost nobody had done any kind of molecular biology or molecular genetics work in the alligator," he says.

Those studies provided the strongest evidence yet that environmental contaminants were impacting gene expression, the process by which genes influence cell growth and metabolism.

Guillette says the polluted lakes are nominally better than they were when he started 20 years ago, but reproductive problems are showing up in alligators from outwardly "clean" bodies of water, raising concerns that even background levels of environmental contaminants can cause problems.

While Lou Guillette focuses on alligators, Elizabeth Guillette uses anthropological techniques to study the effects of environmental contaminants on humans.

Photography by Kristen Bartlett

What About The Kids?

Children were always the primary concern of Guillette's wife whenever he discussed his work in the field.

"I would come home and talk about what was happening with alligators and she would say, 'Well, what about the kids? And I would say 'Kids are too difficult to study.'"

So Elizabeth "Buzzy" Guillette, an associate research scientist in the UF anthropology department specializing in health and culture, set out to find her own answers, uncovering an ideal natural laboratory in Mexico's Yaqui Valley. During the country's Green Revolution of the early 1950s, residents split philosophically about large-scale pesticide-based agriculture. Those in the valley embraced pesticides, herbicides and other agricultural chemicals, while those who opposed the approach moved to the foothills and avoided them entirely.

"The divisions it created among families reminded me of a civil war," she says.

Ultimately, stark differences emerged in how the children developed, according to Guillette's research, which was featured in the Discovery Channel documentary *Toxic Legacies*.

She devised play activities, including drawing and catching a ball, to compare such skills as memory, coordination and balance and found the pesticide-exposed children lagged far behind those living a more organic lifestyle. In a second study, girls born to mothers in the valley did not develop normal amounts of breast mammary tissue, raising questions about whether they would ever be able to nurse babies.

"These groups were the same in every respect, culturally, genetically and socio-economically, except for their use of pesticides," Guillette says. "They had the same diet, the same child-rearing practices and the same school system."

The pesticide-related research of the Guillettes — even though one studied alligators and the other children — was influential in the implementation of a pesticide ban in Halifax, Nova Scotia, that has spread to about 100 Canadian cities. Unfortunately, Guillette says, effecting such change in the United States has been much harder.

"The great thing about both of us working with contamination from very different angles is we discuss, but never argue about, our work," she says. "He's not in a position to tell me how to do my research and I certainly don't know how to do his."

When she needs help in statistics, though, he advises her, and when he could use an extra hand on the boat, she goes along.

Scholarship Not Studentship

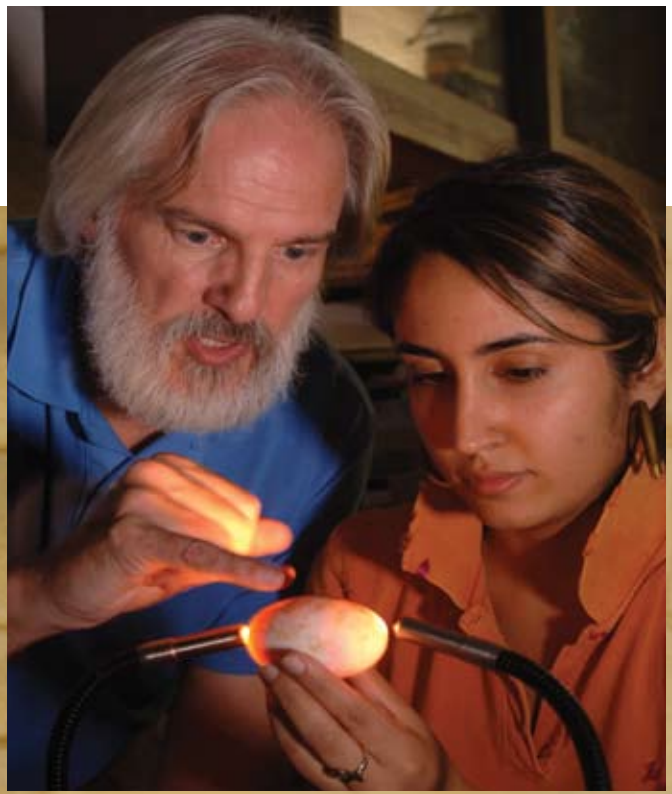
Letting students experience science firsthand is a hallmark of Guillette's teaching style, which he defines as "scholarship" not "studentship."

"One of my greatest frustrations with the way we teach science is that we sit students down in classes or even laboratories, tell them what is important and have them memorize something as they would a poem or their multiplication tables, so students end up getting the sense that science is not discovery," he says. "'Scholarship' is what we should be teaching — the pursuit of knowledge — not 'studentship,' sitting down and having someone tell you what's important.'"

As a result, a vast majority of Americans don't understand the scientific process or realize that science is constantly changing — whether it is stem cell research or global warming — unlike a poem or multiplication tables, Guillette says.

With the Howard Hughes Medical Institute grant, Guillette is developing a new course titled *Communicating Complex Ideas in Science* that will bring world experts to campus to sit down and talk with students in small groups. The hope is to make a series of short films about these visits for use in K-12 and undergraduate classrooms.

Using Internet video links, scientists from different parts of the world also will be invited to join Guillette's traditional lab gatherings of graduate and undergraduate students and share their perspectives as experiments are designed and the results interpreted.



Kristen Bartlett

The excitement of scientific discovery will not be confined to the collegiate experience. Guillette plans to build a multigenerational mentoring program involving high school students, undergraduate and graduate students, giving them the opportunity for hands-on research experience in both the lab and field.

Guillette has always tried to create opportunities for his students to experience real science.

Chris Tubbs, a former student now in a doctoral program at the Marine Science Institute at the University of Texas, says he first experienced Guillette's teaching style in an introductory biology course.

"I just sat there in class like most students, very wide-eyed and amazed at how he was teaching us," Tubbs says. "Even in a class of 200 students, you felt as if he were personally talking to you."

Guillette's dedication to his students truly sets him apart, says Ed Orlando, another former student who is now an assistant professor in biological sciences at Florida Atlantic University.

"There are a lot of brilliant, productive scientists like Dr. Guillette, but I don't know how many of them care as much as he does for such a large umbrella of people," he says. "It's like having your father be a world-class scientist."

Guillette has a profound philosophical commitment to education, says Allan Burns, a UF anthropology professor who knows the Guillettes personally and professionally. "He really believes that he can't learn more unless his students are learning alongside him," he says.

Louis J. Guillette Jr.
Distinguished Professor, Department of Zoology
(352) 392-1098
lou.guillette@gmail.com

Elizabeth Guillette
Associate Research Scientist, Department of Anthropology
(352) 392-2253
eguillet@anthro.ufl.edu

Kim Pace

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>
> — Lou Guillette

Science for Life

David Julian (left), zoology associate professor and director of the HHMI Core Lab; chemistry professor and Science for Life Director Randy Duran; UF students Danyell Wilson and Kristen Misiak; and Morehouse College undergraduate Allman Rollins.

UF students and faculty soon will have access to a new interdisciplinary science laboratory in UF's Health Science Center complex, thanks to a $1.5 million grant from the Howard Hughes Medical Institute.

The grant in support of undergraduate science education will leverage investments from UF and partners to total more than $3.8 million.

"The HHMI award will bring together early undergraduates, graduate students, postdoctoral fellows and faculty members campuswide to teach and learn from each other in a way no other facility in the state does now," said chemistry Professor Randy Duran, the grant's lead researcher. "UF has a very talented freshman class, and we want to make stimulating opportunities available to these students."

The university will use the grant money to create the HHMI Undergraduate Core Laboratory at UF's Health Science Center. The facility will be devoted to cross-disciplinary teaching and laboratory work.

"We hope to fund 70 to 100 HHMI freshman research awards annually in a program called Science for Life," said Ben Dunn, distinguished professor of biochemistry and molecular biology and co-director of the student research part of the program. Working with UF's College of Education and colleagues in engineering, medicine and agriculture, the program also will establish a new science education minor allowing hundreds of UF students to pursue high school science teaching jobs. An extramural research program will send more experienced undergraduates to Scripps Florida and to some of the most outstanding life science research laboratories in Europe.

Thanks to more than 150 faculty from 49 academic departments, freshmen will learn interdisciplinary research early in the core lab and quickly move on to conduct independent research projects mentored by graduate students, postdoctoral fellows and faculty members.

The grant also has enabled UF to partner with Morehouse College in Atlanta on two major programs. The first is to establish a teaching postdoctoral fellow program. Postdoctoral fellows will teach in the HHMI Core Lab and work on collaborative research projects, spending a year teaching and doing research at each institution. They will receive additional mentoring from Catherine Emihovich, dean of UF's College of Education. Typically, postdoctoral fellows conduct research at one institution and rarely receive training in teaching or mentoring. When the fellows sign on as new faculty members at any college or university, UF will pay each an additional $20,000 to help get them started.

In addition, UF and Morehouse will jointly award HHMI Term Professorships to at least 27 faculty members who demonstrate excellent undergraduate mentoring skills. The awards of $10,000 over a two-year period can be spent at the faculty member's discretion.

HHMI has supported undergraduate science education at the nation's colleges and universities since 1988, providing 247 institutions of higher learning with nearly $700 million.

Randy Duran
Professor, Department of Chemistry
(352) 392-2011
rduran@chem.ufl.edu

Allyson Beutke DeVito