When Jessica Kissinger speaks, listen closely. She’s in a hurry. An airplane may be waiting to take this internationally respected expert in parasite genomics to a conference in Europe or Asia. A student may be standing in the hall waiting to discuss a grade. Or, most important, she probably needs to get back to work on her research, which is helping rewrite how scientists use computers to study disease.

An intense woman who has trouble sitting still, Kissinger only begins to relax when she starts to explain her work on the genomes of parasites and how learning more about them can lead to new drugs that can spare sickness and death among the earth’s suffering millions.

Her office in the Biological Sciences Building on South Campus is nondescript, as if the intensity around her remains in the realm of ideas. With a growing reputation as one who is linking computers with biology, Kissinger doesn’t have much time for small things when she gets to the office each day. She sees the future and wants to help shape it.

On her sixteenth birthday, Jessica dropped out of high school in Chicago, left the house, and went to work selling cigarettes, newspapers, and gum at Union Station. Her family moved frequently when she was growing up, and the pain of establishing new friendships and being ignored or treated badly by educators who couldn’t settle on her skills level were finally too much.

“Once when I changed schools, I was immediately demoted two grades,” she says. “It was awful not to fit into a certain category or with a certain clique.”

About that time, her parents, scientists and intellectuals themselves, moved to Washington, D. C., and Kissinger decided to go with them and give high school one more try. After finishing summer school, she should have started as a junior, but the school instead put her back with the freshmen, because it didn’t recognize Chicago credits as equivalent, and after six weeks, she dropped out again.

Discouraged but needing a job, she landed a position as a computer billing clerk in a medical clinic—a position that strangely enough pointed her toward her future as a scientist. She was there only a few months,
leaving it to head off with friends to Germany to protest the deployment of Pershing and Cruise missiles, living with “squatters” and making her voice heard. Arriving back in the U. S. several months later, she took a job as a bookkeeper in a doctor’s office in Washington.

“The mail we would get included the CDC’s Morbidity and Mortality Weekly Report,” says Kissinger, “and I was just fascinated with it. Every time you mentioned a new disease in a doctor’s office, the idea was the same—let’s kill the bug. But from an evolutionary point of view, I was just fascinated by the organism itself.”

Realizing she had a new and intense interest, she took and passed the GED, began taking some courses at George Washington University, and then applied for college by starting at the top: Harvard, the University of California at Berkeley, and the University of Chicago. She laughs now, thinking of her lofty ambitions, but by then she was beginning to bring her interests together with greater maturity than most new high school graduates. Fortunately, she was accepted by Chicago, and she—not without irony—headed back to the city she had fled.

Once there, she studied evolutionary biology, of course, but she also showed a deep interest in a field some might find more arcane: the history and philosophy of science. In truth, that cross-disciplinary and cross-cultural kind of thinking has colored her work since then, but at the time, she couldn’t be sure how it would fit.

She was still troubled, as she studied resistant bacteria, that the main method of preventing the diseases they cause was to “kill the bugs,” as opposed to understanding them. At the end of her third year, she realized that what she really wanted to study was molecular phylogeny—how traits evolve in organisms at the molecular level. If science understood disease-causing organisms better, she reasoned, there was almost certainly a better way to control them and the diseases they cause.

At the time, there were only three schools in the country that offered in-depth study in molecular phylogeny, and she selected Indiana University as the place to work on her doctorate after graduating cum laude from the University of Chicago in 1989.

While working on her Ph.D. at Indiana, she studied the evolution of development in sea urchins, using that fascinating creature as the basis for her research on the processes of evolution. She finished her degree in molecular, cellular, and developmental biology (with a minor in genetics) in 1995.

Still interested in disease processes, Kissinger spent a year on a postdoctoral fellowship with the National Institutes of Health in Bethesda, Md., where she began to investigate Plasmodium, the parasite that causes malaria, a disease that still sickens or kills millions of people each year. After a year at NIH, Kissinger and her new husband, Gennaro Gama, went to his native Brazil, where she spent 1996-1998 as a postdoctoral fellow in an institution in the city of Belo Horizonte. She took a final postdoctoral fellowship at the University of Pennsylvania, and it happily turned into a lectureship.

While at Penn, she came up with the novel idea of using paper clips to help students understand the algorithms for estimating molecular evolution and identifying patterns.

“Effective pattern matching is the key to solving many bioscience problems, and understanding the rules for identifying patterns is
essential to developing the algorithms needed for effective bioinformatics," wrote Beth Schachter in an article on Kissinger in Bio-IT World in 2002. "Kissinger gives her students five minutes to diagram the relationships among the paper fastening devices. The ‘straight’ piece of metal is meant to be the ancestor. Students wrangle with how to group and relate the fasteners. What is more important: color, shape, size, composition? They quickly learn to see conflict within the data—not all fasteners of the same shape are the same color; not all fastener of the same color are the same shape or size.”

With several full-time professional positions to consider, she finally took her first full-time faculty position at UGA in 2002 in the Center for Tropical and Emerging Global Diseases and the department of genetics.

A simple listing of Kissinger’s research interests along with a short description would fill up the next few pages of this magazine. But one might divide her work into two areas: Call them Data World and Bio World.

Start with Data World. Working the UGA’s department of computer science and her own extensive skills, Kissinger is developing databases, for parasitic genomes, that are changing entire approaches to research in both genomes and the computer applications needed to utilize them.

There are numerous scientific databases online these days, and ones with genetic information are crucial to researchers studying, among other things, how genes act and why. The problem is that most of these databases can’t “talk” to each other, and in many of them, accessing information in useful ways is difficult if not impossible.

“What we’re doing is using cutting-edge bioinformatics to integrate diverse data sources and allow databases to talk to each other,” says Kissinger. The new ideas are changing databases from information sources into research tools.

A good example of Kissinger’s database work is TcruziDB—the database for genomic information on Trypanosoma cruzi, a “kissing bug” parasitic organism that causes Chagas’Disease, a serious health problem that affects millions in South and Central America. (Check it out at http://TcruziDB.org). Kissinger’s gift, however, may lie as much in the technological aspects of such databases as their scientific sides. As she notes, once the tools exist, they are not organism-specific. In other words, the elegance and utility that make TcruziDB a valuable research tool for scientists can be incorporated into databases on numerous other organisms, such as CryptoDB, another UGA parasite database for an important AIDS pathogen.

The possible uses of such databases are dramatic. Scientists can examine entire genomes and compare gene sequences to existing sequences in other organisms, for example, and find where similarities exit.

The issue of understanding parasitic diseases isn’t some arcane ivory-tower pursuit. Take one disease as an example for many. According to the World Health Organization, there are 300 to 500 million clinical cases of malaria each year resulting in a staggering 1.5 to 2.7 million deaths. Children aged one to four are the most vulnerable to infection
and death, and malaria is responsible for as many as half the deaths of African children under the age of five. The disease kills more than one million children - 2,800 per day - each year in Africa alone. In regions of intense transmission, 40 percent of toddlers may die of acute malaria, and about 40 percent of the world’s population, about two billion people, are at risk in about 90 countries and territories.

David Sibley, a professor at Washington University in St. Louis, takes note of the position Kissinger is coming to occupy in the scientific world because of the kind of work in her “database side.”

‘Jessie is tremendously inquisitive about all areas of biology and this really shows in her excitement in talking about ideas and working with others on a wide range of topics,” he said. “She combines a unique appreciation for how organisms are built and how they function in their environments with an analytical approach to understanding their histories and inter-relationships. She has recently been involved in developing tools to understand the mountains of genome data that have been generated in the past few years. Much like the human genome, the completion of parasite and pathogen genomes is providing us with an avalanche of new data. Deciphering this information is an important undertaking that will guide us into the next era of biology. Some call this `post-genomic biology,’ but to Jessie it is clearly just fun as she tackles this complex problem with energy, enthusiasm, and a unique combination of skills.”

Kissinger works steadily with another unit of the Franklin College, the department of computer science, to refine and develop new ideas and improvements for databases such as TcruziDB. This has placed her on the cutting edge in the relatively new field of bioinformatics, since the databases she uses will implement “web services,” a new technology that will allow the rapid exchange of information with similar databases.

Knowing so much about the genetic structure and composition of parasitic diseases has also begun to change how medical science is approaching the control of disease. Is the best idea to wipe out the “vectors”—such as mosquitoes that carry malaria? Or might there be a better way to intercede medically without having to carry out widespread spraying that could harm fragile ecosystems? Bioinformatics is helping us find out.

While Kissinger’s fascination with her Data-World is growing by the day, her work in Bio-World is just as intense and revolves around the relatively new field of comparative genomics. She and her research team focus on (but are not limited to) studies of the phylum Apicomplexa, which includes an estimated 5,000 species, all of which are believed to be parasitic.

The Apicomplexa have a rich evolutionary history that makes understanding them in the laboratory setting a crucial adjunct to the database work. Kissinger’s lab now has a number of projects underway on such species as Toxoplasma and Cryptosporidium—along with others that also cause human illnesses.

One advantage in working with the Apicomplexa is that their genomes are relatively small, meaning that they can be more easily studied than larger and more complex ones. (All the Apicomplexa are estimated to have from 5,000-7,000 genes.)

As information on these species is uncovered in the lab, it is put into the appropriate database—creating a synergy that gives researchers new clues into how the species work and how their disease-causing
mechanisms might be disrupted.

“We are also now able to start asking important questions such as what makes a good drug target,” says Kissinger. “The trick for all these species is to find a drug that inhibits the organism without harming or sickening us.”

That means finding active genes in these organisms that are not in humans and determining whether they play a role in virulence or disease transmission.

The need is urgent. Science at present has no efficient cure for any of the diseases caused by Apicomplexan parasites such as malaria or toxoplasmosis. Drug design has had two basic approaches. The so-called “historical approach” describes what Kissinger calls “growing an organism and then throwing every possible chemical compound at it, see what happens, and figure out why.”

A new strategy, called the “rational approach,” however, involves using comparative genomics to find novel pathways or genes in the organism that will allow the creation of drugs that more specifically target them.

Kissinger notes that she is not a drug-target-discover scientist per se.

“But that is a natural outflow of what we are doing,” she adds.

While her work with Data-World and Bio-World are intense, Kissinger expresses an equally strong passion for teaching, and in addition to her students at UGA, she has been a frequent teacher to groups all over the world through the World Health Organization. She is also a frequent and happy traveler, enjoying her trips around the world to meet others, both scientists and non-scientists. Kissinger is gaining honors, too, and in June she was named winner of a Young Investigator Award from the Seventh International Congress on Toxoplasmosis.

At home, she loves to spend quality time with her husband and their daughter, Victoria, who will be four this month.

As her reputation grows, Jessica Kissinger may have to travel less, because with each passing day, the world, taking note of her achievements, is coming to her.