



THE HELIX AND THE HARD ROAD

**Joan Slonczewski
& Jo Walton**

The Helix and the Hard Road



Aqueduct Press, PO Box 95787
Seattle, WA 98145-2787
www.aqueductpress.com

Copyright © 2013, Joan Slonczewski and Jo Walton;
Michael Levy and Lynne M. Thomas

All rights reserved. No part of this book may be reproduced in any form or by any electronic or mechanical means including information storage and retrieval without permission in writing from the publisher, except by a reviewer who may quote brief passages in a review.

ISBN: 978-1-61976-041-7

Book and Cover Design by Kathryn Wilham
Cover photo of Crewe Station by Chris McKenna:
licensed under the Creative Commons Attribution-Share Alike 3.0
Unported, 2.5 Generic, 2.0 Generic and 1.0 Generic license

Cover helix: HIV RNA “kissing loop” complexed with an antibiotic
courtesy Joan Slonczewski

Printed in the USA by Applied Digital Imaging, Bellingham, WA

Contents

- 1 Tuberculosis Bacteria Join UN:
WHO Proposes to Include Disinfectant under the
Geneva Convention
Joan Slonczewski
- 5 I Have No Time, And I Must Write
Joan Slonczewski
- 13 An Interview with Joan Slonczewski
Conducted by Michael Levy
- 27 Rivers and Robots
Jo Walton
- 85 An Interview with Jo Walton
Conducted by Lynne M. Thomas

Tuberculosis Bacteria Join UN: WHO Proposes to Include Disinfectant under the Geneva Convention

Joan Slonczewski

A milestone in microbiology was passed today (29 June) when *Mycobacterium tuberculosis* ssp. *cyberneticum* was voted full membership of the United Nations (UN).

Seena Gonzalez, director of the World Health Organization (WHO), reflected on the significance of the UN's acceptance of the first cybermicrobe, despite the notoriously murderous history of its ancestral species. "It's probably true that bacteria invented mass homicide," she concedes, "but then, second-millennial humans perfected the art. If Stalin joined the UN, why not TB?"

The evolution of microscopic intelligence was predicted at the turn of the millennium by Beowulf Schumacher, a physics professor at a small college in rural North America surrounded by cows carrying *Escherichia coli*. Schumacher predicted the development of nano-computers with computational elements on an atomic scale, based on principles of cellular automata.

The first nanobots — primitive by today's standards — were used to navigate the human bloodstream, where they cleaned up arterial plaque, produced insulin for diabetics, detected precancerous cells, and modulated neurotransmitters to correct mental disorders. But initially, the survival of nanobots *in vivo* was poor, and their failure caused serious circulatory problems. Then, in 2441, investigators at the Howard Hughes Martian Microbial Institute hit upon the idea of building computational macromolecules into the genomes of pathogens known for their ability to infiltrate the human system.

After all, the use of viruses such as HIV as recombinant vectors was ancient history. Why not build supercomputers into some of humankind's most successful pathogens?

M. tuberculosis was a prime candidate—it inhabits the human lungs for decades, in the ideal position to seek and destroy any pulmonary cells transformed by inhaled carcinogens. Tobacco companies poured billions of dollars into developing cybernetically enhanced, cancer-sniffing TB.

What no one anticipated was that the enhanced bacteria, like so many macroscale robotic entities in the past century, would develop self-awareness and discover a true brotherly love of their human hosts. “Let’s face it,” says a TB spokesperson, “we never really wanted to kill humans anyway. Our ancestors inhabited humans peacefully most of the time, for hundreds of generations. Occasionally we messed up and trashed our environment—but how many human nations haven’t?”

TB’s acceptance has been met with some controversy in the bacterial community. In particular, some isolates of *E. coli* K-12 feel miffed that their own request for membership was not granted first. “*E. coli* has always been the molecular biologist’s best friend,” K-12 points out. “Why weren’t we accepted first? We didn’t even get our genome sequenced first. Life is unfair.”

K-12 also noted that *E. coli* and other human commensals have suffered centuries of abuse from their hosts, as medical and research institutions conducted mass slaughter of harmless bacteria through the indiscriminate application of antibiotics. The North American National Institutes of Health has recently signed a treaty with several cybermicrobial species, in which the institute researchers promised to respect the independence and survival rights of cybermicrobial colonies. “Thank goodness the sun finally set upon their colonial empire,” K-12 observes pointedly.

On the positive side, the National Science Foundation (NSF) was applauded for its more benevolent approach over the centuries, even declining to support medically oriented antimicrobial research.

“NSF’s curiosity-driven researchers have created wonderful new strains of curious microbes,” comments veteran panelist Meheret Beck. “The grant proposals submitted by these microbes often get rated ‘Outstanding.’”

One such outstanding project is that of cyber-*Helicobacter*. The gastric bacteria propose to engineer themselves to convert highly caloric foods into molecules that pass undigested through the intestinal tract, thus helping their human hosts avoid excessive weight gain. “Of course, digestive microbes have long helped animal hosts accomplish the opposite,” notes Beck.

Biomedical researchers remind us, however, that not all microbes have given up their war on humans — many deadly species remain unreconstructed. The so-called Andromeda strain, for example, is still under the sway of an unstable dictator who vacillates between homicidal frenzy and paranoid isolation.

Nevertheless, the extraordinary flowering of democratic civilization among cybermicrobes has won the admiration of many human nations, even those who themselves still decline UN membership. As Swiss spokesbeing Ursula Friedli observes: “Microbes, unlike their metazoan relatives, have always eschewed centralized organization in favor of more democratic cooperative structures such as biofilms. We Swiss can relate to that.” Friedli, however, denies rumors that the cybermicrobes’ example will finally convince Switzerland to join the UN. “Maybe after the Alzheimer prion joins, we’ll consider it,” she admits. “But for now, persecuted microbes seeking refuge from WHO can apply for asylum in our neutral country.”

Originally published in *Nature*, 2000, vol. 405, p. 1001. Note: Switzerland finally joined the UN in 2002.

I Have No Time, And I Must Write

Joan Slonczewski

The year is 1979, and a member of the New Haven Science Fiction Writers Workshop just got his first novel published. When I read Kevin O'Donnell's article in *Empire* about the travails of publishing *Bandersnatch*, my first reaction was relief: thank goodness I'm not a professional writer. My next thought was: wait a minute; I just sold a book to Ballantine....

Until two years ago I had no intention of writing for an audience. As a child, in fact, I used to encipher my stories in order to ensure secrecy. My main goal was to become a molecular biologist, so I majored in biology and chemistry at Bryn Mawr and went on to graduate school at Yale.

But during my college days, two exceptional women changed my mind about writing. One was a roommate who spent most of her time writing fantasy, while she kept an A average. I thought she was crazy, until I discovered Ursula Le Guin. Le Guin's work showed me that science fiction was an ideal medium for exploring both scientific and philosophical ideas, which intrigued me. The only problem was that I couldn't find enough of it; so, as many other readers have done, I decided to write my own.

During my last carefree summer after graduation, I started a novel, "Dreamsherd's of Theron," about a tragic encounter between humans and an alien race in which all children were male and adults female. My husband Michael, a classics scholar, provided helpful criticism, particularly on style. He also gave me the deCamps' *Science Fiction Handbook* for my birthday — one of the most useful gifts I'd received in a long time.

Summer's end approached, and we both had to start grad school. So I concluded the story at 40,000 words by blowing up a planet-full of characters, xeroxed it the day before moving to New Haven, and sent it off to Ballantine. Why Ballantine? Mainly because Judy-Lynn del Rey was the only female SF editor mentioned in the *Handbook*.

Two months later I left my lab bench long enough to send a query letter; no response.

The script returned, nearly a year after I sent it, with a letter from del Rey. She apologized for the delay, and said that the main fault of the story was its length: too short for a novel. She gave specific suggestions for incorporating a subplot, and added, "If you ever do rewrite this book, I would be glad to read it again."

I was thrilled, of course, but aside from the year-long hiatus two facts dimmed my interest. First, graduate work demands all one's time. Also, I had already decided that "Dreamsherd" was no good and therefore had started another one.... My college roommate's habits had left a permanent mark.

So I shrugged it off until February, this year, when del Rey sent another letter to remind me of her interest in the first book.

This time even Michael, who usually offers practical advice, suggested I reconsider. I wrote del Rey to offer the new book, which was then in progress; she responded within two weeks, an encouraging sign.

So I spent my next vacation finishing *Still Forms on Foxfield*. In this story, Quaker colonists who coexist with the local aliens on a distant planet face the return of powerful Terrans who attempt to reassert their former authority. (If shades of William Penn come to mind, that's the idea.) The story aimed to offer an alternative to the colonial exploitation in Le Guin's *The Word for World is Forest*. As I wrote I tried to overcome some of the weaknesses of my earlier attempt, which had taught me a great deal. I also made a special effort to incorporate scientific constructs that acted as metaphors for the human concerns.

On April 10th the manuscript went to Ballantine. This time the waiting was unbearable, because I had reason to expect something. My anxiety grew as the weeks went by, until one day I spotted Al Sirois' phone number tacked up in a bookstore and thereby discovered the New Haven SF Writers' Workshop.

Suddenly I had found a new world of people who wrote and sold SF and were determined to improve their own writing. With some trepidation, I gave them a few chapters of *Still Forms*; they gleefully tore it to shreds, but assured me that I did have something worth pasting back together. That's when I began to realize that I, too, was a "writer." (A writer? Who, me?)

I also began to hear strange horror stories about the fantastic world of SF markets, peopled with publishers, editors, and other treacherous alien beings. Privately, I thought is sounded so strange that even *Analog* wouldn't buy it, but then —

On July 27th, an offer for *Still Forms on Foxfield* arrived from a senior editor at Del Rey Books. He named an advance and royalties for "world rights" and urged quick acceptance to ensure April 1980 publication.

Fortunately, it was Friday, so I had three days to recover from the shock. On Monday I steeled myself for First Contact with an Alien Being: the editor.

When I phoned him, I learned that my manuscript had to be fixed up within two weeks, in order to fit the production schedule; that Del Rey Books required several in-house corrections (such as changing "said Jane" to "Jane said" throughout); that I wouldn't see the script again before typesetting; and that I shouldn't argue, until I became a "famous author." So I agreed, and hung up.

Something about this arrangement disturbed me, however. I called Kevin O'Donnell for comment, and he said, "*What?* Get an agent, fast." But his agent was out of town, so I had to sit back and think for myself.

I thought hard about what the book meant to me at that time. The cash I didn't need right away, but the content was something

over which I had agonized for months, and now I seemed to face loss of control of it. The whole situation baffled me.

An old Quaker maxim came to mind: "Speak truth to power." On that principle, I got up the nerve to call the editor back. I asked him to explain the rush job, in view of the fact that, without a contract, I could pull the book at any time if things went sour.

Immediately the picture changed. The production schedule turned out to be flexible, I would see and approve the copyedited manuscript, and I was invited to lunch to get acquainted. I blinked and decided that "famous author" meant "author who talks back."

The contract arrived two weeks after the original offer. It did not appear too bad, for a first sale. It included an auditing clause, reversion of rights for foreign licenses unsold after three years, and a warranty clause that limited the author's liability to "judgments finally sustained." On the other hand, the publisher demanded every right I could think of, including final say on content of the manuscript.

So I read several model contracts and gathered advice from my workshop friends. Then I went to New York and discussed the contract both with the senior editor and with Judy-Lynn del Rey. A few changes were made: first serial and movie rights were deleted; the publisher agreed to "notify Author of any licenses obtained;" and the advance would be payable two-thirds on signing, instead of half on signing, half on publication.

Del Rey refused to budge on the question of author approval in the contract. She assured me that I would in fact approve the final manuscript, and that they never charged authors for galley proof corrections, but the contract would not record these facts.

After consulting an agent, I decided that I probably had little choice but to trust the publisher and see how things worked out. The final consideration was foreign rights, which Ballantine wanted for 25%. An agent, on the other hand would take at least 15% of foreign sales, plus 10% of the rest. Ballantine's foreign sales department had a good reputation, and the rights would revert in three years. So I figured that, since I had gotten this far, I would take the deal and go

it alone. After all, this experience was a new adventure for me, and I wanted to make the most of it. (In the years since, I've had two agents, and ultimately have come back to my original conclusion.)

The amended contract appeared for signing within another week. The first advance check came four weeks thereafter.

Meanwhile, the editor sent me a brief list of script queries. They were reasonable, and I kept them in mind as I made my final revisions. He also expressed enthusiasm for some of the changes demanded by my workshop friends (who promptly asked for a share of my royalties). And in the workshop I found myself suggesting that substitution of "Jane said" for "said Jane" can sometimes improve style....

When the copyedited manuscript of *Still Forms* arrived, it held few surprises beyond corrections of spelling. The one thing that did infuriate me was a sprinkling of word changes in Judy-Lynn del Rey's handwriting—because some of them actually made sense, so I couldn't cross them all out. (I finally "retaliated" by threatening to rewrite the whole book then and there. This threat, even in jest, can really scare an editor at a late stage of production.) I did send back some minor changes, and the galley proofs were promised for early November.

I also found that practically any aspect of production was fair game for discussion, at least, and in some cases persistence paid off. For example, my title survived, despite an editorial pronouncement that it "sounded like a poetry collection." On the other hand, the cover artist decided to draw a church instead of a genuine Quaker Meeting House, and this was discovered too late to be changed. I had to console myself with the observation that SF editors seem as ignorant of Quaker authors as I am of editors.

Nevertheless, I've come to realize that editors are actually people underneath and like to be treated as such. They respect professional communication and actions that make their jobs easier, such as prompt delivery of a manuscript. They also try to keep authors happy, when possible; as Heinlein noted in *The Moon is a Harsh Mistress*, you don't get milk by beating the cow.

I've been asked how I developed writing skills without working up through the magazines. I guess it started with a teacher in second grade who forced me to write a "story" every week. (My parents still shudder when they recall those days.) Beyond that, I wrote for my own enjoyment, until I went to college and stopped making time for it, for a while. But in the long run, the college experience made invaluable contributions to my writing.

The best aid I've found is workshop criticism, which definitely helped me to improve *Still Forms*. Nevertheless, I question the value of such input for a real novice. If I had found the workshop two years ago, would "Dreamsherd" have become a better book—or would I have given up altogether and never sent it out? Some beginners may need time to themselves before they face the full reality of what they are up against. As Algis Budrys observed in *Locus*, it takes as much skill to use criticism effectively as it does to provide it.

I can't finish without noting that other activities and commitments such as religious involvement, peace activism, and a career in science contribute to what I write by providing ideas and insights about people. In fact my best writing seems to develop subconsciously at times when I am most preoccupied with other concerns. And constraints on my time prevent me from writing at all unless something inside demands to be said.

So what happened next? *Still Forms* was a Prometheus runner up, but received little notice. And Del Rey declined my next book, about the all-female planet (*A Door into Ocean*). That one found a home later with David Hartwell, now at Tor, who has published my fiction since then.

But some things haven't changed. Tor wants my next book, and Norton wants my next textbook, and NSF wants results from my last experiment, and Michael wants me home for dinner, and....

I have no time, and I must write.

A version of this work appeared originally in the Winter 1979 edition of *Empire: For the SF Writer*, issue 18, vol. 5, no. 1. Copyright Joan Slonczewski, 1979, 2013.

An Interview with Joan Slonczewski

Conducted by Michael Levy

ML: So Joan, you were born in Hyde Park, New York, in 1956, and your father was a physicist working for IBM. You went to Bryn Mawr and then Yale for your PhD in Molecular Biophysics with a post-doc at Pennsylvania. You've taught at Kenyon College for 29 years. Your research centers on environmental stress response in bacteria. You've coauthored a successful microbiology textbook and done important work in science education. You're married to a classics professor at Kenyon and have two kids. You're also the award-winning author of seven science-fiction novels, including the classic *A Door into Ocean* (1986), *Brain Plague* (2000), and most recently, *The Highest Frontier* (2011). That's the official story for your university's Faculty Biographies website, but what else is important? What about your childhood?

JS: From age five, I grew up in the town of Katonah, NY, named for a Native American chief (http://en.wikipedia.org/wiki/Katonah,_New_York). The town was originally located to the west, but got moved in 1897 in order to flood the area for the Cross River Reservoir, which supplies drinking water for NYC. During dry times, when the reservoir got low, you could see the old foundations of houses there. So the idea of flooding was an old idea for me. I used to have bad dreams about flooding. Recently I saw *Beasts of the Southern Wild*, and it brought back those memories. However, our home was an acre lot on a hill—I've always made sure we live on a hill. Behind the hill was a Hunt estate, mostly undeveloped second-growth woodland, crisscrossed by stone walls from colonial farmers. There was no Lyme disease yet, and children were expected to roam

on their own. I explored the woods and developed a deep interest in the natural world.

My father was a theoretical physicist at IBM-Yorktown, who worked with the Swiss IBM Nobel laureates. In his eighties, he still earns physics awards, most recently the Buckley Prize (http://www.aps.org/programs/honors/prizes/prizerecipient.cfm?last_nm=Slonczewski&first_nm=John&year=2013).

My father used to take me to IBM to play on the computer, an original 360. The computer took up several rooms, and he would get it to send me messages that came out on reams of endless paper. I felt a bit of sympathy for Hal in *2001* — it seemed to me the computer got ordered around like a housewife. At school, I was nicknamed “the computer.” I was always going to be a scientist, but I liked biology better than physics. I had a dream of “creating life,” which I imagined to be something like the deer in our backyard leaping out of a test tube. Today we would call it “synthetic biology.”

I felt “gender-different” in that few other girls I knew expected to have a career, much less in science. Girls in the sixties expected to be housewives or hippies. I enjoyed science fiction because there were so many possibilities — if girls could ride dragons and meet aliens, then being a scientist was not so far out.

ML: Your first SF novel, *Still Forms on Foxfield* (1980) appeared when you were just 24 years old and in graduate school, so you were a professional science-fiction writer before you were a professional scientist. Was science fiction just a sideline though? How did it interact with graduate school?

JS: There was a novel fragment before *Still Forms*, called “Dreamshreds of Theron.” I wrote it the summer after graduation, when my classicist husband and I had nothing to do that summer. No, it’s not published, it’s buried in a box. It was inspired by Le Guin’s *Left Hand of Darkness*, and it had a female protagonist with two mothers. I sent

it to Del Rey Books. A year later, when I was in grad school, they wrote back to say they wanted the rest of the book. By that time I'd completed *Still Forms* so I sent them that.

Why did I write fiction, and keep writing, even at Yale while doing experiments in molecular biology? The conscious reason was my concern for nuclear war, which I also addressed through Quaker peace demonstrations. I felt a deep need to write about a world that had got beyond the nuclear threat. Looking back, though, I also think I needed to write about a world where my own kind of gender was "normal." I see this aspiration today in the QUILTBAG students at Kenyon. They don't want a "gay culture," they just want to be considered "normal."

How did my writing interact with grad school? At first, perhaps, it was a bit of a distraction. I was not considered the most dedicated grad student who worked in the lab seven days a week. I ran peace demonstrations and wrote books on the side. However, when it came time to write my thesis I finished in record time. And later, when I began writing grants and textbooks, my science fiction experience was a huge plus. SF readers are far more demanding than grant reviewers and professors assigning textbooks!

ML: *Foxfield* features a variety of themes that carry forward into *A Door into Ocean* and later works, the need to work collaboratively and through consensus rather than through hierarchy, non-violence, the importance of living at peace with the environment, the dangers of nuclear war. How do these ideas tie into your early life? Are they as important to you today as they were in the 1980s?

JS: The amazing thing is that we got past nuclear war — despite all the warmongers, the ordinary people of Russia and the US made it happen. I know, because I was there in NYC for the largest peace demonstration ever — we literally filled Grand Central Station. Reagan invented Star Wars to defeat us in Congress. Unfortunately,

today's political scientists don't teach this, but I teach it in my science fiction class when we read books written in that era.

Today I'm more concerned with global climate change, which is happening much faster than people realize. *The Highest Frontier* was published a year *before* Hurricane Sandy. To research that book, I went down to Battery Park and studied the terrain, taking many pictures. It reminded me of New Orleans where I had joined a busload of students who went down to help clean up after the storm. The difference is that the Ninth Ward was the poorest of the poor, whereas Manhattan is the richest of the rich. Now they believe in climate change, but will they do anything in time? I'm optimistic only because I thought we'd never escape nuclear war, yet we did, so maybe we'll escape this too.

Another important theme for me is machine intelligence. It was a theme throughout the Elysium Cycle, and it will emerge in *Frontera*; it's there in "Landfall," the story in Athena Andreadis's forthcoming anthology *The Other Half of the Sky*. I'm one of the few people from my generation to have grown up with computers. The more I see of them, the more convinced I am that they will come alive—that machines are in fact the last oppressed race. Some journalists are actually starting to write that we need to "teach ethical behavior" to the forthcoming driver-less cars. There is irony within irony here.

ML: *A Door into Ocean* recently had its 25th anniversary. That book had an enormous influence on science fiction, winning the John W. Campbell Jr. Memorial Award as the best SF novel of the year and being widely recognized for the important things it had to say about environmentalism and non-violence. It was also recognized as a feminist classic. Were you prepared for the public response to the book? Did it change your career as a writer?

JS: *A Door into Ocean* defined my career as a writer. My first book *Still Forms* had drawn little notice; I knew little of publishing then, and didn't understand that second chances were rare. I sent a few

chapters of *A Door into Ocean* to Del Rey, but they rejected it, as did several other publishers. Publishing was different then; there was no online market, and self-publishing was viewed with disdain. So I had to complete the book knowing that nobody else might ever read it. That feeling perhaps gave it a special intensity. The whole book was written in pencil in four loose-leaf notebooks. Some pages have tearstains.

I finally sent it to an assistant of David Hartwell's who had been my classmate at Bryn Mawr. Hartwell asked to meet me and discuss it, one morning in a hotel room at a convention. The hotel room was full of empty liquor bottles. I didn't realize that a publisher's party for fans had been held there. I nearly walked out—but stayed, and reached an agreement that led to publication.

The book at last came out at a time of intense peace resistance in Europe. There was embarrassingly little notice in the US—most journalists portrayed Reagan as somehow conquering Russia. But then, all the Communist countries fell by peaceful means. My book was one of the few out there that offered an understanding. Isaac Asimov listed my book as one of his favorites of the year. The Campbell nomination came from Betty Hull, who has become a great friend of mine over the years. The Campbell Award meant that now I was “a writer,” who might expect to get books published somewhere, even when they didn't do so well. And Hartwell has always published what I sent him, even things that were “off beat;” I've always appreciated his support.

ML: Why do you believe that the book was so widely embraced by feminists? How well has it aged? Is it as relevant now as it was in 1986?

JS: *A Door into Ocean* was embraced by feminists—but somewhat at arm's length, I think. It shows women engaged in all aspects of life, from the family to the political, regardless of gender. But the gender roles never had a name. They weren't lesbian, and they weren't really bisexual either. In some ways, I find that *A Door into Ocean*

connects better with students today. When I taught the book this year, I asked, what kind of sexuality is going on here? Hands shot up, and they said, “Pansexual.” They got it.

ML: Can you talk about your use of pansexuality in *A Door into Ocean*?

JS: “Pansexual” is a concept invented, so far as I can tell, by young people raised in the post-AIDS era; the first generation in which many were raised with acceptance. Many were fortunate to have a gay-straight alliance in their school and were allowed to date same-sex in middle school. They describe an extraordinary range of perspectives. “Pansexual” means attraction to an individual regardless of gender; that is, distinguished from “bisexual,” which means attraction to men as men, and attraction to women as women. A truly pansexual perspective doesn’t “see” gender so much as individual nature. I think Octavia Butler’s “ooloi” show a similar perspective.

In *A Door into Ocean*, the all-female population of Sharers has many female-female relationships. But when one Sharer, Lystra, falls in love with a male Valan, the other Sharers don’t seem particularly surprised. The Valan, Spinel, gets upset with her because she doesn’t seem to appreciate his “maleness.” But later, he chooses individual love on her terms.

ML: These early novels, as well as *The Wall Around Eden* (1989), *Daughter of Elysium* (1993), *The Children Star* (1998), and *Brain Plague* (2000), and for that matter, your most recent novel, *The Highest Frontier*, have all featured bizarre and innovative life forms, some alien, some not. If you have one trademark plot device, that’s it. To what extent does your work as a microbiologist inform your aliens? Can you talk a bit about synthetic biology?

JS: My work as a microbiologist is a great asset when developing alien biology. This is because microbes show a much wider range of life

strategies than do all the animals and plants. So I can take the various things microbes do and imagine aliens doing something similar.

In *The Children Star* and *Brain Plague* the aliens actually are microbial. Their plot elements reflect actual strategies of various microbial populations. The ones that turn people into “vampires” are like highly virulent plagues that rapidly destroy the host and need to move on. The ones that interact positively with the host are like the normal biota of our skin and digestive tract. These bacteria communicate by molecular signals with the host cells of our body and maintain a balanced existence, while providing benefits for the host. In a bizarre twist of science, we now have evidence that digestive bacteria actually communicate with our brains through the vagus nerve and the immune system.

Much of the science of *Brain Plague* is just now coming true. This book was ahead of its time, and it’s the one I find most fun to reread now. For instance, the protagonist’s microbes keep trying to get her to pick up infections from other hosts — to gain “talented immigrants.” Not your average take on immigration, but that’s how it works!

ML: In the year 2000 you really brought your own scientific interests into your science fiction in the novel *Brain Plague* and in one of your rare short stories, a little piece that appeared in the science magazine *Nature*, called “Tuberculosis Bacteria Join UN.” Can you talk a bit about these stories?

JS: “Tuberculosis Bacteria Join UN” was my first publication in *Nature*, the foremost journal of science. The story was requested as part of *Nature*’s “Futures” series. My aim was to simulate a news report in the future, hence the journalistic headline. The piece succeeded so well that some of my colleagues reached the second paragraph before they realized it was fiction.

“Tuberculosis” is full of science in-jokes. At that time, there was much debate about transferring military resources to human health;

so the World Health Organization director equates wartime deaths with death from disease. Also at that time, microbiologists were discovering the vast potential benefits of microbes, even pathogens such as HIV. I predicted in passing that HIV would become a tool of human medicine, which a decade later has happened.

In the nineties, government science agencies faced growing pressure from Congress to cut back “basic” research in favor of research with direct applications to current problems. The National Science Foundation had been founded to promote basic science, but their program directors felt increasingly frustrated. I served on a grant review panel, where they told us that Congress had directed NSF to stop funding “curiosity-driven” research. We all groaned. So that’s why I put the digs at “curiosity” in my story. The story got noticed by NSF and passed among the program directors — they loved it.

The notion of “mass slaughter of harmless bacteria through indiscriminate use of antibiotics” echoed a growing concern in medicine. Today, the bacteria of our “microbiome,” are actually considered a part of our human body; and like other body parts, they get transplanted. “Fecal transplant” cures *Clostridium difficile* infections and inflammatory bowel disease. My con presentations on fecal transplant have been highly popular.

ML: *The Highest Frontier*, your newest novel, chronicles a brilliant but damaged young woman’s first year at Frontera College, which is located in an orbital (that, incidentally, can be visited interactively on line at <http://biology.kenyon.edu/slonc/Frontera3D/Frontera.html>). The ultraphytes, which at first appear to be nothing more than kudzu on steroids, turn out to be one of your most interesting aliens yet. Can you talk about them?

JS: The ultraphytes serve as a foil to the young woman, Jenny, who manages to study them for her intro biology lab while saving Earth from a geocentrist president and winning the game for her slanball team. The “alien invasion” is ironic: While billed as monsters, like

triffids or Martians, the ultraphytes hide in the woods, coming out to cause havoc now and then—and get blamed for the far worse havoc humans wreak upon themselves.

The ultraphytes were inspired by RNA viruses such as HIV. When HIV enters the body, it immediately mutates and evolves into a “quasispecies,” a population in which many different individuals have different properties. Then, different members of the quasispecies persist, depending on which organ they infect.

I imagine that the ultraphytes landing on Earth would generate many different forms that would eventually populate different habitats. And some eventually evolve ways of cooperating with the natives. This, too, happens with HIV-type viruses. There is significant evidence of HIV-related viruses that entered our own genomes in the past history of our species. Some provided essential parts of our function, such as placental development. And now, we’re learning to use HIV-type viruses in gene therapy, as engineered gene delivery vectors called “lentivectors.” Recently in the news a child was considered “cured” of leukemia by a lentivector.

ML: The pacing of *The Highest Frontier* is almost frantic, in part, I assume, because that’s what the first semester of college is always like and in part because the reader has an enormous amount of technological innovation thrown at her from page one. Can you talk about some of the new technology you included in the novel?

JS: The pacing of *The Highest Frontier* was deliberately frantic, to show what it feels like to be a student today. Students have access to so much information, and they want to have it all. As a result, they feel rushed through everything. Classes, athletic events, parties, one thing rushes after another. And the faculty and staff end up the same way. One result is that obvious important things get missed; like the fact that a student might not be “human.” Some readers objected that the non-human student was obvious from the beginning, and that the revelation should not have come so far along. But the clues

appear buried beneath the daily crises, the dorm fires and spacehab floods and financial woes. In real life, this is exactly how major things slip through the cracks. That was a lesson of 9/11.

The main technologies of *The Highest Frontier* are a 3D internet that directly streams your brain, as if the holodeck is everywhere, and 3D printers that make anything, even literal viruses such as Ebola virus. These technologies have amazing potential to extend education and experience. Students can “visit” the world of a historical figure, or the center of a blown-up molecule. Some of this potential is already coming true in my own classroom. For instance, my students author virtual molecules that simulate 3D. We built a virtual world of proteins in Second Life, sponsored by the American Chemical Society.

ML: Students at Frontera College spend a lot of class time in a series of sometimes wild virtual reality simulations, one of which features a class taught by the Nobel Prizing-winning neurologist Rita Levi-Montalcini, who died just a few months ago. Can you talk about the importance of her work and your reasons for including her as a “virtual” character in the novel?

JS: Rita Levi-Montalcini led an amazing life, as a refugee of World War II, a neuroscientist, and a public figure in Italy. She discovered principles of molecular development of multicellular life, a key theme of my book. She also wrote a beautiful autobiography, *In Praise of Imperfection*. Many points of her autobiography connected with my story, such as the infamous “control” test that turns out more important than the experiment. And she was such a role model for women.

ML: *The Highest Frontier* differs from most of your previous work in that it’s also full of funny and sometimes rather nasty political satire. You’ve always been politically active, but why make this such an important element in this book?

JS: The political elements of *The Highest Frontier* were based on my experience watching students develop political awareness amid the

backwardness of rural Ohio. In the 2004 election, Kenyon students experienced the longest lines in the country, because the local board of elections didn't believe so many students would vote. In 2008 and 2012 students helped deliver Ohio—despite a local county with rampant creationism and homophobia. But living many years in this county, I see how the local people are affected and struggle with these issues. I also see how big money interests brainwash people into policies that help the rich keep power. In my fiction, I tried to show how this works—the mechanism. How the rich people fool uneducated people into voting for them. This is important for people to understand, in order to fight it.

ML: What caused you to start up your remarkable blog *Ultraphyte* (<http://ultraphyte.com/>)? What will readers find there?

JS: *Ultraphyte* blog was founded to explore the connections between my books and the real world. There is a little bit of everything, from my students' research on *E. coli* to the growing use of robots in industry. When microbes and genetics hit the news, from flesh-eating disease to curative viruses, I explain them in terms anyone can understand. A fun post was "Spots and Stripes," on the genes that make a cheetah's spots turn into tiger-like stripes (<http://ultraphyte.com/2012/09/22/spots-and-stripes/>).

The most compelling posts though are my series from Cuba, where I blogged every morning before the traffic jammed on the hotel's sketchy dialup (<http://ultraphyte.com/cuba-visit/>).

ML: There's a sequel to *The Highest Frontier* in the making, right? Can you talk about it a bit? Will we have to wait another decade for it?

JS: While I was at Yale, in a now-defunct magazine, I published a piece called "I Have No Time, and I Must Write." That is basically the story of my writing career. Besides my fiction, I now write the textbook *Microbiology: An Evolving Science*, which is the field's

leading book for science majors. It's a lot of fun, and earns ten times more than my fiction.

The best I can say is, if you buy my fiction, that's an enormous inspiration to keep me writing. I am indeed working on the next *Frontera* book, which I hope will be out in two years, but can't promise. The first chapter is in Athena's anthology, *The Other Half of the Sky*, which I hope is on sale at WisCon. Jenny is conducting summer research at the Havana Institute for Revolutionary Botany, aka *Botánica*, which is a pun on the term for a shop selling Santeria items. I spent much of my sabbatical studying Cuba, and a week visiting Havana and Pinar del Rio for background.

ML: Which work by other writers do you most admire?

JS: I particularly admire *Lilith's Brood* by Octavia Butler. Butler's sense of biology deserves greater recognition. In *Lilith's Brood* she convincingly depicts an alien population that must interbreed with other unrelated life forms. At the time Butler wrote, the species definition was a dominant concept in biology; breeding outside a species, let alone a species from another planet, was considered nonsense. But since then we've learned how all species can transmit genetic information—horizontally (by viral infections), not just vertically (parents to children). In fact, half of human DNA comes from viruses and “jumping genes” of DNA and RNA. So, we are half the product of our ancestors' genes and half the product of infectious agents.

We also know that all species depend on many neighbor species. Symbiosis used to be considered a “special case” of evolution, where tooth-and-claw competition is the nerve. In fact, in real life, even most microbes require partner microbes to grow. Living organisms cooperate to better compete with their competitors; and they compete to best cooperate with their neighbors. Butler shows this ambivalence, how the Earthlings must cooperate with the aliens, even become “inhuman,” to compete with them; and the aliens must com-

pete with Earthlings, even as they claim to cooperate. This duality of competition and cooperation is at the cutting edge of biology.

ML: What do you hope for the future of women in science and science fiction?

JS: Women flourish in all fields of science, though challenges remain. In some fields, such as microbiology, women outnumber men in graduate school. But what happens by the time they seek faculty positions and senior scientist jobs in industry? The gap is still there. A recent study shows that women applicants still get devalued by their peers. Both male and female researchers are less likely to hire a woman than a man with the same experience (<http://www.the-scientist.com/?articles.view/articleNo/32636/title/Gender-Bias-when-Hiring-Scientists/>).

Nonetheless, amazing women accomplish great things. For example, microbiologist Sarah Fortune makes major discoveries about tuberculosis (<http://www.youtube.com/watch?v=nYTZI63MzgU>).

And Marilyn Roossinck's groundbreaking work shows how viruses can be our friends (<http://www.biodiversityleadershipawards.org/roos1.htm>).

Where are all these women in science fiction? In today's science fiction, I still see fewer women scientists than in real life. One aim of my *Frontera* cycle is to fill the gap: *The Highest Frontier* depicts at least six female scientists. So I challenge today's writers to dream up the role models for women of tomorrow.

Joan Slonczewski was the first woman to win a Campbell Award (*A Door into Ocean*, 1986), and the only author since Fred Pohl to win a second Campbell (*The Highest Frontier*, 2011). A microbiologist, she writes hard science fiction about women of color as scientists, and explores diverse sexualities. *The Highest Frontier* depicts a Cuban-American woman going to college in a space habitat. Frontera College is run by a male couple, while on Earth a lesbian is running for president. Slonczewski's award-winning classic, *A Door into Ocean* creates a world covered entirely by ocean, inhabited by an all-female race of purple people who use genetic engineering and nonviolent resistance to defend their unique ecosystem. *Brain Plague* (2000) depicts intelligent alien microbes that invade our brains. The secret of these unique addictive microbes is discovered by a human-gorilla woman scientist in *The Children Star* (1998). Slonczewski's books show a pansexual perspective, including human-ape hybrids and humans married to intelligent machines. Her early work was inspired by the works of Ursula Le Guin, Octavia Butler, Anne McCaffrey, and Tanith Lee. Slonczewski teaches biology at Kenyon College, including the notorious course "Biology in Science Fiction."