The immune system as an invisible, silent Grand Fugue

Luke A J O'Neill & Cliona O'Farrelly

The Science Gallery, Trinity College Dublin, recently held an exhibition called "INFECTIOUS: STAY AWAY" that used art to illustrate infection and immunity. Luke O'Neill talks to one of the artists, Gordana Novakovic, about her involvement in this project.

An exhibition that recently ran at the Science Gallery, Trinity College Dublin, called "INFECTIOUS: STAY AWAY" (http://sciencegallery.com/infectious), attracted a lot of attention from the general public. Partly as a result of the recent scare over swine flu, almost 50,000 visitors passed through the exhibition between April and July 2009. There are plans to take the exhibition to selected centers in the United States. The visitors came to be enlightened, amused, frightened and entertained by scientific and artistic exhibits on the theme of infection and immunity, and also to participate in actual experiments.

"Infectious" is a combination of science, works of art inspired by the notion of contagion and whimsical oddball exhibits to illustrate infection and immunity. This unusual mix makes "Infectious" unique internationally and is a key aspect of the 'brand' of The Science Gallery at Trinity College, which bills itself as a place "where ideas meet." A key component of the exhibition was the world's first live public epidemic simulation using radio-frequency identification tags. Other exhibits included tennis ball–sized glass viruses, the water flea daphnia 'singing' in response to bacteria (in an exhibit called "NOBODY LEAVES 'TIL THE DAPHNIA SING") and a wedding dress made from a cut-up microbiology textbook (which we must presume tells us something about modern marriage!). There was also an 'immune lab' in the gallery, where visitors could extract their own DNA, which was then analyzed for the gene encoding the Toll-like receptor adaptor Mal. Subsequent analysis revealed the Mal genotype and risk of malaria and tuberculosis, which the visitor could find on a website. We are using these data to examine this gene in the Irish population.

What made "Infectious" work and why would artists be drawn to it? For scientists, it was a way to tell nonscientists about our passions. It also gave scientists the chance to meet and talk to artists on a common theme and look for overlaps and possibly inspiration. Gordana Novakovic, an artist famous for combining painting with newer electronic media, had an exhibit at "Infectious" called "Fugue." Luke O'Neill asked her some questions on "Infectious" in an effort to understand her involvement and participation.

Why did you get involved in "Infectious"?

I was first attracted by the Science Gallery's distinctive concept, and also by the profile of the curatorial team, which included Michael John Gorman, director of the Science Gallery, who has worked at Harvard and Stanford on the history and philosophy and science; Don Pohlman, exhibits manager of the Science Galley and formerly of the Science Museum of Minnesota; Cliona O'Farrelly, who is Professor of Comparative Immunology at Trinity; and yourself. I believed, correctly as it turned out, that a curatorial team drawn from experts in the relevant scientific and artistic disciplines, rather than just from broad specialists in public engagement, would provide a much more diverse and complex framework and a more interesting choice of participants. The "Infectious" exhibition itself, marked by some spectacular design and an imaginative theatrical script, embraced an eclectic but strangely seamless mix of scientific demonstrations and art, and offered an exciting and challenging framework for the small-scale, intimate and meditative presentation of the "Fugue" project.

What was the inspiration behind "Fugue"?

Artworks often have a long gestation period, and their development is usually very nonlinear and understandable only in retrospect. The visual aspects of "Fugue" took shape many years ago, in a long series of abstract paintings with a strong cellular theme, exploring the similarities between the micro- and macro-cosmos. Some 5 years ago, when I began to work on the piece that became "Fugue," I was inspired by contemporary theories of the digital revolution, the global city and globalization, and the way that fear spreads (and is spread) through the mass media, mutating as it goes, in a manner very similar to a pandemic. I first conceived the theme in terms of the spread of a virus of fear through my home city's circulation system—the London Tube network. However, security concerns made it difficult to continue with this plan. (This was well before the 7/7 bombings, which made the whole idea seem more real than abstract.) I knew that I wanted a complex, multilayered, spatially distributed architecture. And because no human imagination can really compete with the work of evolution and natural selection over countless millennia, I decided to look at the dynamics of intercellular communication in biology, and that inevitably led me to the immune system.

Luke A.J. O'Neill and Cliona O'Farrelly are in the School of Biochemistry and Immunology, Trinity College Dublin, Dublin, Ireland.
e-mail: laoneill@tcd.ie

Detail of "Fugue" graphics. A group of cells and platelets are bound to the damaged vessel wall by fibrin. In the middle foreground, polyhedral antibodies adhere to a small cell. The cell at the bottom is illuminated from the inside, showing that it is infected.

As an artist, what struck you about the immune system?

I was immediately stunned by both the beauty and the still-mysterious nature of this hidden immune universe within our bodies, by its multi-channeled interconnections with different spheres of human physiology, and how, in a dialog with the brain, beyond and beneath our awareness, it governs and sustains our lives.

Searching for a metaphor that would express something of the nature and complexity of immune system functions and that would also represent the interplay between the different disciplines and personal philosophies within the project team, I looked at classical music forms involving polyphony and found what I wanted in the architecture of fugue. It seemed to me that this musical form, regarded by many as the most complex and sophisticated in the history of music, could provide a model and a framework for expressing what appeared to me as a magnificent, invisible, silent Grand Fugue of life in our bodies. Inaccessible to our senses, it keeps the memory of our ancestors, learns through direct interaction with the universe of microorganisms and keeps in its own diary the accounts of our lifestyle and habits from birth to death.

Describe "Fugue"

In "Fugue," a virtual immune system engages with a virtual virus. I assumed that I would first have to learn a lot more about immunology and then convey what I wanted to a computer programmer, but to my surprise I discovered a scientist in the Computer Science Department at University College London, Peter Bentley, who had been working for years on a computational models of the functions of the immune system within the new field of artificial immunology. He agreed to work on the piece, and together with the new music composer Rainer Linz, a long-time collaborator of mine, we set up our core team, to which we later recruited four other scientists, including immunologists and computer experts.

At the heart of the piece is a complex piece of scientific software, a version of Peter's artificial immune system algorithm, which mimics the cascading responses to infection of the human immune system by simulating the interactions in time and space among individual virus particles, antibodies, the immune system and other cells in a circulatory vessel. No two responses will ever be the same, and the time scale and outcome of the struggle is always unpredictable. However, "Fugue" does not display what might be seen under a microscope. Instead, we have transformed the data generated by the artificial immune system into visual and auditory symbols that express the dynamics and the rhythm of the biological processes. While the visuals reflect one view of events in the system when a vessel wall is damaged and an artificial virus enters, the sound reflects another, and always in a new and unpredictable way. At "Infectious," we invited visitors "to watch and listen, and become attuned to the processes and rhythms that are mirroring what might be happening right now, inside your own body."

How useful is "Infectious" in terms of getting artists and scientists to interact?

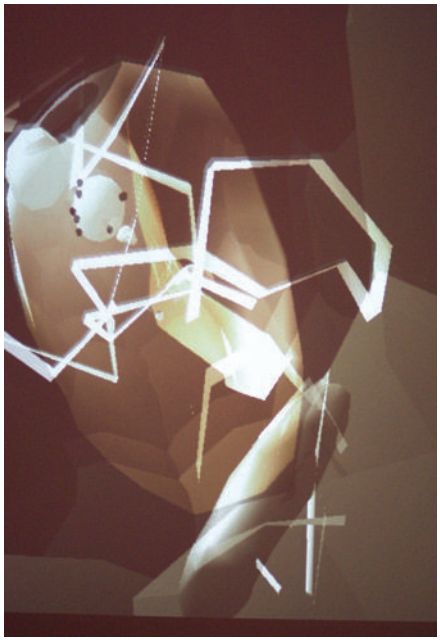
I think "Infectious" has been useful in two different ways. First, during the setting up and the opening week, there was a lot of contact between the participating artists and scientists, who had to work together with a strong sense of common purpose and urgency. You can often learn more about something from seeing what sorts of problems it gives rise to, and how they are dealt with, than from seeing it in its final form. I learned a lot about bacteria, and I made some contacts that may well affect my work in the future. In my role as artist-in-residence in a science department, I organize regular talks by artists and scientists on the topic of art and science collaborations, and I have already invited some of the people I met in Dublin to give presentations in this forum.

The second way in which "Infectious" has been useful is that it has been so obviously successful in engaging the public, underlining the potency of the mixture of art and science. There was an excellent balance of very different approaches to the theme, juxtaposing straight scientific demonstrations with artworks addressing philosophical, ethical and aesthetic concerns, and my feeling is that all the individual pieces somehow came together very harmoniously. And because this success has now become a story for the media, the message will have reached lots of artists and scientists who were unable to attend the exhibition.

I have been working in art and science for many years now, and I am always impressed with how often an exhibition open to the public is viewed with a more open-minded spirit than one that is restricted by its context to either artists or scientists. (The problem, of course, is that artists tend to see the subject as just science, and scientists see it as just art.) What was clear from "Infectious" was that the two strands were working in a complementary way and that each gained from the presence of the other. I think that this perception will act as an encouragement for scientists, in particular, to think about working with artists.

What are the challenges of getting artists and scientists to work together?

One of the major potential barriers preventing fruitful associations between artists and scientists is that the two source disciplines have very different approaches to judging the validity of a piece of work. In successful collaborations between artists and scientists, it seems



Detail from "Fugue" graphics. The small white cell, near the top left against the background of a large platelet enveloped in fibrin, is under attack from several virus particles, which in turn are threatened by an antibody.

to me that each must accept that the methods and judgments of the other are valid within the discipline concerned and that neither has a monopoly on all forms of knowledge and understanding. Once this is achieved (and it doesn't always happen without a struggle), it becomes clear that artists and scientists have much in common, especially where the still-mysterious processes of creativity and inspiration are concerned. But the first and most important step is to engage in interaction, and I'm sure that "Infectious" will have encouraged this enormously.

How do you think immunologists might benefit from the interaction with artists?

It is difficult to avoid the usual question; it is clear that the art in the "Fugue" project gained a lot from the hybridization with immunology, but what is there, if anything, for the scientists? If it is seen purely as a kind of visualization of the immune system, I would say probably nothing at the moment. Our focus was art, and so we simplified Peter's already quite abstract software, retaining only what we needed to realize our concept—and, in the full version, adding an interaction driven by the participants' positions and movements, for which there is no analog in the real immune system. However, as both artists and scientists know, inspiration and the creative spark have peculiar origins, and this is where "Fugue"—or perhaps a more complete and accurate version of "Fugue"—might play a role. Given our limited sensory capacities, the immune system and its functions are too complex to be perceived in full and as a whole from graphs or static lists of numerical data. Could it be the case that seeing, hearing and perhaps even physically influencing the spatio-temporal rhythms of a virtual immune system—in other words, engaging with the data from an entirely different viewpoint—might trigger a fruitful train of thought that otherwise would have never occurred? For example, when Florian Dombois transformed the frequencies and time scales of his seismological recordings so that he could listen to them, the characteristics of the human auditory system immediately revealed patterns that had remained undetected until then. This technique of sonification, or auditory data display, has now become routine in certain fields. I have no real idea whether our art project could give an immunologist an idea that he or she would not otherwise have had, but I would have to admit that such a result, however welcome, would be accidental rather than intended.