Brave new world

Scientific and technological breakthroughs are changing the face of cancer research – early diagnosis and vaccines against cancer are waiting in the wings. As Nick Kirby finds, these innovations are creating plenty of opportunities for career advancement.

"This is a watershed time for cancer research. We are entering a new era as we start to see a revolutionisation of the information that has been gathered over the past 30 years. Not only are we seeing the development of 'designer' drugs that target specific cancers, there is also a shift in emphasis towards early recognition and intervention. It's a very exciting time."

As someone who has been in medical research for 30 years, the majority in cancer research, Dr Ceryn Johnston should know. Johnston, who is President of the National Cancer Institute of Canada and associate dean of research for the Faculty of Medicine at Dalhousie University in Halifax, Nova Scotia, has seen how cancer research has been transformed in the past two decades.

"Not so long ago, research was all about understanding how cancers behaved and devising appropriate treatments," he says. "While that is still true, there have been significant breakthroughs in recent years – not least with the Human Genome Project and in computational and molecular biology. Techniques have evolved that have changed approaches to cancer." 

Scientific advances

This evolution has taken place in many cancer epiphanies. Dr O'Donnell-Dormey, executive director of the New York-based Cancer Research Institute (CRI), which funds research in North America and worldwide, cites the cancer immunity field as making significant inroads into the prevention and treatment of a range of cancers.

"Antibody Therapies have been used for some time now with great success in the treatment of some cancers, including tumour-targeted antibodies and antibody therapies that are combined with other therapeutic modalities like chemotherapy and radiation," she explains. "Well-known monoclonal antibodies include Rituxan for the treatment of non-Hodgkin's lymphoma and Herceptin for the treatment of metastatic breast cancer. She continues: "Clinical trials are currently underway that would allow oncologists to draw upon the immune system's ability to specifically target dangerous cells or other pathogens to direct otherwise non-specific toxicity so prevalent in traditional chemotherapy and radiotherapy. This way, their effects are inflicted only upon dangerous cells, while healthy cells are left unharmed."

The numbers game

The need for changes in methodology becomes obvious when looking at the incidence of cancer in North America. The American Cancer Society estimates that in 2005 there will have been 1,372,910 diagnoses and 570,280 deaths from cancer of all sorts. And, according to the Canadian Cancer Society, Canada will have seen 149,000 new cases and 69,500 deaths. It should be noted, however, that these figures have stabilized in recent years. This is a direct result of the advances that continue to be made in cancer research and treatment, not only from laboratory work on a pharmaceutical or molecular level, but also in behavioral psychology, through the understanding of nicotine addiction and associated cessation techniques. Education is also having an impact through an emphasis on self-checking and the promotion of regular medical check-ups. A significant paradigm shift in cancer research focuses on early identification and vaccination.

"The problem has been understanding what the earliest changes that take place are," explains Dr Johnston. "One initiative that is taking flight is in biomarkers -

$72bn

The cost of cancer treatment in the US in 2004

The number of breakthroughs are expected soon in the search for cancer vaccines.
identifying how a change to any cell component indicates a measure of health status. In the case of cancer, this means trying to identify proteins that are expressed in pre-cancerous cells.

He envisions a blood test that could identify the early onset of a cancer, meaning that treatment could begin sooner. Early treatment could have the advantage of being less aggressive than some of the current regimens or radiation that more advanced cancers require.

Dr. O’Donnell-Tormey looks towards vaccination as a key area of growth in the near future. In particular, she cites cancer vaccines that have shown immense promise, not only for the treatment of existing cancers, but also for preventing the development of cancer.

“Therapeutic vaccines employ various delivery methods designed to train the immune system to recognize protein or protein products specific to cancer cells,” she says. “These vaccines are ideal for confirming not only immediate treatment of cancer, but also prolonged immunity against cancer.”

“We believe that cancer vaccine research is poised for dramatic clinical breakthroughs within the next decade.”

Working together

Understandingly, the advances in science are creating a wealth of new research, and new fields are emerging. This is creating a need for much better collaboration between researchers, foundations and companies.

Dr. Johnson explains, “The classic model was that an investigator would put in a request for funding, do the research, publish and then move on to the next piece of work. What this did was build a knowledge base. But, as he points out, this type of methodology meant that people were operating, in isolation until their research was published. A new approach to cancer research is what now has him so enthusiastic.

“Different kinds of science require different types of interaction,” he explains. “There is good communication between people operating in clinical trials and now is the time to start working in a more systematic fashion. It’s vital that we put the resources in place to put teams together.

“It is the type of collaboration that allowed the Human Genome Project to be completed – and it needs to be applied to cancer research more broadly now.”

Dr. Karen Peterson is staff scientist and associate for interdisciplinary training at the Fred Hutchinson Cancer Research Center in Seattle. She runs programs and develops courses that allow postdoctorates to experience different aspects of cancer research, giving them opportunities to cross-train and to become better collaborators.

Dr. Peterson talks about Dr. Johnson’s emphasis on collaboration by illustrating the vast range of options available in cancer research.

She says: “There is an enormous variety of positions, from laboratory technician to quality-control analyst to principal investigator. There are biostatisticians, clinical researchers, molecular biologists, pharmacologists, radiologists, nutritionists and psychologists.

Case study

Xiongqing Zeng is a German Research Institute (GRI) postdoctoral fellow at the Memorial Sloan Kettering Cancer Center in New York. He graduated with a M.Med degree from Shanghai Second Medical University in China and has a PhD in Immunology from the University of Edinburgh in the UK.

After studying molecular mechanisms of bacterial and fungal autoregulatory diseases in China, he looked for a laboratory in the West with an emphasis in immunology and genetics for my PhD training. I chose to pursue my PhD with Professor Nick Nachreiner at the University of Edinburgh. He is a leader in the field of infection disease immunology and immunopathogenesis.

At the end of 2000, I started my postdoctoral work with Professor Jason Allison at the University of California at Berkeley. He is an investigator at the Howard Hughes Medical Institute and a leader in the field of immunology, particularly in developing ways to help the immune system to recognize and destroy cancer cells. I believe that immunology holds immense promise for development of novel cancer treatments.

My work at Berkeley was on the co-stimulatory molecule family regulates the activation of T lymphocytes, a macrophage of the immune system. This led to the discovery of B7s, the newest member of the co-stimulatory molecular family. One of the exciting things about B7s is that it not only inhibits T lymphocyte function, it also expressed on some cancer cells.

My major work is on cell biology, with an eye on new therapies and diagnosis. The US is a wonderful country for research. I have been exposed to the GRI fellowship and have many chance to discuss new ideas and unpublished data with scientists worldwide during its annual symposium. I am currently at the 4th stage of my immunology training and now to think about what I am going to do next. I’d like to have my own laboratory, researching basic immunology and diseases in this country.
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Help wanted
As cancer research moves so quickly, expertise gaps can arise. Dr. Petrosian says: "You may be surprised that there are vacancies that are not being filled. Molecular epidemiology is a growing field that needs more personnel. Computational biology is another area that is growing and his opportunities.

This is a theme picked up by Dr. Michael Rosenick, executive director of the National Cancer Institute of Canada. "There are certain under-served areas where there are real gaps," he explains. "Not only do we need knowledgeable workers — people who can make a connection between what goes on in the laboratory and what happens at the bedside — we also need more people in the areas of social science and behavioural research and prevention research. After all, we can't prevent what we don't understand."

And then there are issues surrounding drug approval for cancer treatment. NCI's Rosenick believes that the dynamics of how drugs are approved and administered in the US need to change. "Drugs that do well on certain cancers do so because they attack a certain gene, one that might also be useful across other types of cancer," he says. "The FDA needs to look at this in a more chloride and more aggressively without approving drugs for use that are generic-specific versus cancer-specific." He believes that students who are committed to championing these types of drugs will do well in the future.

Outstanding issues aside — or perhaps because of them — cancer research in North America continues to attract eminent scientists in the field. Dr. Petrosian points out

Money matters
Of course, cancer research cannot be undertaken without appropriate funding from both the public and private sectors. In 2004, federal funding for the National Cancer Institute stood at approximately $4.74 billion, of which $3.3 billion in the form of grants, was spent specifically on research. This work is addressed in research into cancer causation, detection and diagnosis, treatment and cancer biology. In Canada, in 2004, the Canadian Institutes of Health Research (CIHR), the country's largest agency responsible for funding health research in Canada, is provided in excess of $150 million for cancer research in the country.

Equally important is the amount of work carried out in the private sector. A recent 

report from research company DataMonitor indicates that oncology is the third-largest global pharmaceutical market — behind the cardiovascular and CNS therapy areas — and in 2004, was worth an estimated $44 billion. Sales of the top 20 cancer drugs in the US in that year alone were worth an excess of $18 billion.

This requires a significant level of investment in R&D. A report in the magazine Drug Discovery World estimates that 15 percent of sales is used in R&D. This would imply an R&D spend on cancer in the US of more than $2.5 billion for 2004 alone.

What is perhaps more significant is that the pharmaceutical companies also understand the need for collaboration — for example, Genentech and Biogen Idec, two giants in the world of drug research, are currently working together on Rituxan.

This also extends to academia and the public sector, be it in the creation of academic

centers, work with universities or the provision of free drugs for investigator-driven clinical trials.

Cancer research never sits still for a number of key reasons — scientific and technological advances that continue to push research forward, the changing nature of cancer and a shifting demographic. According to the NCI, cancer will always pose a challenge. They

’You can work at the lab bench, asking questions about how cancer occurs at gene level, you can work in epidemiology and ask questions at the population level about how cancer arises, such as what the contributing factors are. You can work with patients and conduct research on the effects of cancer treatment from a psychological perspective if you are a psychologist with a PhD,’ she says.

Other cancer options include: finding a PhD in nutrition or a doctorate in pharmacology and taking a beam at a cancer treatment center, or gathering data for an epidemiological or clinical study as a research subject interviewee.

It is because of this range of disciplines that Dr. Peterson welcomes Dr. Johnston when it comes to a more collaborative approach to research. "Not only has cancer research become broader, but as science advances, the range of tools at the researcher's disposal has become more complex," she says. "Take proteomics, for example. Certain aspects are so complex that it makes much better sense to speak to an expert than to try to figure it out yourself. This is breeding a much more collaborative environment.

Just networks are being set up. As Slas says, vice president of the National Foundation for Cancer Research (NFCR), a non-profit organisation based in Bethesda, Maryland, points out: "We support our own global network of research centers. The key is that we link all of our centers together so that information sharing and advances in one field advance discoveries in others."

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Federal funds allotted to the National Cancer Institute for cancer research in the United States

That many people come into medical research, particularly cancer research, and stay in the field for their entire professional careers. There are also those who transition from another field, but this is a relatively small amount. Nevertheless, Dr. Peterson says that "wonderful who have been trained in another field, such as chemistry, computer science or engineering, may have some very interesting insights into how to solve current problems that same-field trained scientists may not have the skill set to solve."

**More than a job**

"Most people feel very fulfilled by their work because they are helping to prevent, treat and cure cancer." Dr. Peterson continues. "There can be a profound sense that you are making a difference in the world. Cancer researchers need to be paid well enough so that they can live comfortably, but I don't think that most people are in it for the money."

According to research published in September 2005, salaries in the US can vary widely depending on the nature of the work and whether you are in the private or public sector. In the survey, salaries ranged from a junior researcher working in academia with a median salary of $31,000 to a senior researcher working in industry at $90,000. Once in cancer research, whether you can move disciplines depends on the job you have. Dr. Peterson explains: "If you are a professor/principal investigator, it is harder to move easily and will take a lot of planning and negotiation." Lab technicians, on the other hand, can move to almost any major US city and find a job reasonably quickly. As Dr. Peterson sums up, "Any good research is constantly changing. Any good experiment will create three more questions. The great thing about cancer research is that you are constantly learning and asking questions. A lot of scientists in the field say they get 'to play' and can't believe they are being paid to do it — they love it. "Many people in cancer research are seeking a higher meaning than just doing the day-to-day grind — they say it gives their work passion, meaning and purpose."

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**Contacts**

**United States**
- American Cancer Society
  www.cancer.org
- National Cancer Institute
  www.cancer.gov
- Cancer Research Institute
  www.cancerresearch.org
- National Foundation for Cancer Research
  www.nfcf.org

**Canada**
- National Cancer Institute of Canada
  www.nccr.ca
- National Institutes of Health
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